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International Abstract of Surgery

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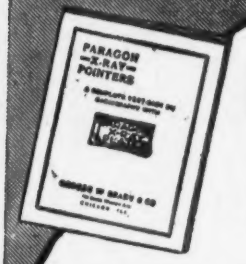

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THE SURGICAL TREATMENT OF EMPYEMA

BY ALEXIS V. MOSCHCOWITZ, M.D.
Major, Medical Corps, U. S. A.

MY interest in empyema was stimulated by an investigation which I and my adjunct, Dr. A. O. Wilensky, instituted in the year 1914. In tabulating statistically the results in 299 consecutive cases observed in Mount Sinai Hospital, New York, during the preceding 10 years, we discovered that the mortality reached the formidable figure of 28 per cent. This was a rude shock to my complacency engendered largely by the conventionally indifferent attitude of most surgeons toward this malady. Of course, it is barely possible that our mortality is an unusual one; but conversations with numerous surgeons throughout the country lead me to believe that most of them suffer from a similar delusion that their mortality in empyema is lower than it really is.

For this reason, I deemed my appointment to the Empyema Commission as a most welcome opportunity, not only to study the disease *en masse*, but, what we so frequently miss in civil practice, to observe the disease from its very inception. This paper is based entirely upon our experiences on 140 cases, observed first in Camp Lee, and subsequently at General Hospital No. 12, Biltmore, North Carolina.

As is already known, the vast majority of these empyemata are due to infection by a hæmolytic streptococcus, and are coincident with or follow a peculiar form of organizing bronchopneumonia, the pathology of which has been ably described by W. G. MacCallum. Most of the cases follow measles. Despite the extraordinary incidence of the streptococcus as the infective agent, these empyemata, except in the earliest stages, do not differ very markedly in their clinical aspects from the empyemata observed in civil practice, which are usually due to the pneumococcus. Nevertheless, it is interesting to observe that even in civil practice, as the records of 574 examinations of pleural exudates in Mount Sinai Hospital show, 133 were caused by a streptococcus. The significance of these figures did not, regrettably, appear to us.

For purposes of study, streptococcus empyema must be divided into three stages: (1) the formative, (2) the acute, and (3) the chronic stage.

I. THE FORMATIVE STAGE

The formative stage is one of the most, if not the most interesting phase of the entire problem. I shall discuss only certain aspects of these phases.

The most striking feature, in contradistinction to cases seen in civil life, is the extremely rapid formation of the pleural exudate. We have seen cases, in which a pronounced exudate developed two days after the very onset of the illness; cases of three or four days' duration are quite common.

The extremely rapid formation of the exudate and its still more rapid infection with myriads of virulent streptococci demand an explanation. It has always seemed to me that such gross infection of the pleural cavity cannot be accounted for by the mere contact extension of the intrapulmonary lesion. My reasoning was based, first, on an analogy derived from a study of peritonitis. Every surgeon with any experience knows that the most pronounced and diffuse forms of peritonitis are due to a rupture of an intra-abdominal viscus. Of course we sometimes see a very extensive peritonitis when there has been no perforation, but these are admittedly uncommon. Second, years ago I made the significant observation that in a number of cases of empyema that came to autopsy there was found a pinpoint perforation of a subpleural pulmonary abscess. This observation struck me forcibly, and I often wondered how common such origins for empyemata might be. For these reasons, I was specially interested in the observation of autopsy results in Camp Lee, and was gratified to note that such perforations were quite frequently encountered. Such origins are furthermore confirmed by other evidences in patients who recover, particularly the development of pleuropulmonary fistulas, as determined by irrigations with Dakin's solution, by X-ray examinations, and by actual inspection at subsequent operation.

The treatment of the cases in this, the formative stage of an empyema is principally that of the underlying malady, and may be termed in very crude language "supportive." Of tremendous importance, and in some cases even of deciding moment, is the question of nutrition. I cannot enter into a detailed discussion of this phase at this place, but refer all those interested to the preliminary report of the Empyema Commission, which was published in the *Journal of the American Medical Association* for August 3 and August 7, 1918.

Whenever there is a suspicion of an exudate into the pleura, its presence and character should be verified by exploratory aspiration. In the early stages this fluid is varicolored and only slightly turbid; occasionally it is sanguinolent. The early turbidity is only partially due to the presence of pus cells, although a number of these can be discerned on microscopic examination; more frequently it is due to the presence of myriads of streptococci. As already stated, the exudate usually teems with streptococci, but, peculiar as it may appear, the streptococci, in spite of the apparently excellent nutritive medium, not only do not multiply, but on the contrary they frequently disappear altogether; and large bottles of exudate may keep sweet for an indefinite length of time.

The most important advice which the Commission offers as regards the treatment of these empyemata during this stage, is not to operate. When the fluid causes a serious embarrassment of the respiration and circulation, as evidenced by dyspnœa, cyanosis, and rapid pulse, it should be relieved very promptly by evacuating it with a Potain or Dieulafoy aspirator. This procedure should be repeated as often as indicated, if necessary even daily. In rare instances this procedure may even be curative. Exception to this rule of non-operative treatment is made only in cases of acute and progressive hydro- or pyopneumothorax which result from the rupture of a large subpleural pulmonary abscess, communicating with a bronchus of considerable size. In these, very prompt operative interference is indicated.

This recommendation of delayed operation is based upon the marked improvement in the mortality statistics since the adoption of this course, and also upon the very high mortality in camps in which operations were undertaken promptly upon the discovery of the infected exudate. These are the practical reasons, but there are sound theoretical grounds as well. At an early stage of an empyema the fluid is free within the pleural cavity, and there are practically none, or only very slight limiting adhesions; in other words, we are dealing with a free hydrothorax, or if one so chose to call it, a pyothorax. If an operation is undertaken at this stage, we convert the only slightly dangerous hydrothorax into the extremely dangerous hyperacute pneumothorax. This brings about the justly dreaded fluttering of the mediastinum with ultimate fixation on the opposite side of the thorax. Therefore, instead of attaining

the desired object, namely, to relieve the embarrassed respiration and heart action, the operation only aggravates it.

There are a number of other, perhaps less important, reasons which favor a delayed operation. The patients are usually very ill from the pneumonia, with its attendant high toxicity, so that even the simple operation of thoracotomy or rib resection, done under local anæsthesia, is badly borne. Miller, in his report, records that many of his patients died promptly after the operation.

Nor can I see any very material advantage in operations which may be termed "intermediate"; for instance the institution of permanent drainage of the pleura by means of a trocar, and subsequent introduction of a catheter. Even with the greatest precaution, air enters the chest sooner or later, with consequent collapse of the lung. Attempts at maintaining a continuous negative pressure have not been very successful.

The after-treatment of early operations is particularly difficult. If a collapse of the lung has once occurred, the organ rapidly becomes adherent in its new location, usually high up in the thorax and close to the vertebral column. If such a patient is fortunate enough to recover from the primary insult, there is usually formed an enormous cavity, which requires a long time and multiple operations before final closure is obtained. Some of the worst cases I have had to treat were such as were operated on in the earliest stages.

It may be argued, that, inasmuch as we have learned that early operation is best for peritonitis, therefore early operation should be advocated for suppurative pleurisies. It must not be forgotten, however, that even if the pleura is anatomically and physiologically identical with the peritoneum, we are dealing in the thorax with certain static conditions, which are entirely lacking in the abdomen; furthermore we must recognize that the functions of the thoracic viscera are vital, and that the cessation of these functions for even a very short period is incompatible with life; a function, the dignity of which is at no time approached by the abdominal viscera.

At this stage the empyema is not the serious element in the illness; it is the pneumonia. In view of these facts I can only close this part of my paper with the urgent admonition *nil nocere*.

If the patient is not operated upon at this stage the exudate loses its seropurulent character and becomes converted into frank thick, creamy pus. Coincident with this conversion a most important change occurs upon the pleural surfaces; adhesions form between contiguous portions of the visceral and parietal serosa at the periphery of the exudate, which collects in the supradiaphragmatic portion of the thorax. In other words, by waiting we have converted the pre-existing free, seropurulent pleurisy, into a closed purulent pleurisy, or empyema, shut in everywhere by limiting adhesions; and thus we have arrived at the second stage.

In anticipation of what I shall have to say later on concerning recurrences, or relapses of empyemata, I shall briefly mention in passing, that in a certain number of cases the process is not quite as simple as this. Adhesions may form in other portions of the thorax, and give rise to abscesses, which may exist singly or in combination with the classical type of empyema. I believe the term "multilocular" empyema, is better than the conventional one of "encapsulated" empyema for these cases, because strictly speaking every true empyema is encapsulated.

2. THE ACUTE STAGE

When this stage has been reached the general condition of the patient has improved to a very marked degree. The temperature is usually lower, and all symptoms and physical signs are improved.

This is the most propitious time for operation. As the lung is adherent at the periphery of the pus, there is no more danger of a further collapse of the lung. The lung is already compressed to the extent of the encapsulated pus, and no matter how large an opening is made, the lung cannot collapse further.

From a viewpoint of therapeutics this part of my paper is perhaps the most important. Trivial as the operation is, each step requires the greatest punctiliousness in its carrying out.

Before the operation a final X-ray or fluor-

oscopic examination is made, in order to determine the most favorable site for the operation.

The subsequent steps may be subdivided under the following headings:

1. *Anæsthesia.* All operations at this stage can and should be carried out under local anæsthesia. Novocaine or procaine in 1 or 2 per cent solution is the anæsthetic of choice. The line of the incision is first injected endodermatically, and from this area the deeper tissues are very thoroughly infiltrated. A simple intercostal incision is preferable. If, however, resection of the rib is considered advisable, it is important to destroy the great sensibility of the periosteum by injecting it separately; a step which can be readily accomplished with a fine hypodermatic needle. On the other hand the division of the rib does not appear to be particularly painful. I believe that with the exercise of care and gentleness a general anæsthesia is hardly ever necessary. In some cases I have attempted conductive anæsthetization of the nerve trunks, but I am not certain that I would ever have been completely successful without any additional local infiltration; failure to obtain a perfect anæsthesia was very probably due to faulty technique.

2. *The superficial incision.* (*a*) *The site of the incision.* In general the site of the incision depends upon the location of the empyema as guided by the physical examination and the X-ray plates. The incision must fulfill two purposes: first, it must afford adequate drainage, and second, it must permit appropriate medication of the cavity. The drainage must be free and unobstructed both in the recumbent and erect posture. In the most common location of empyemata, i.e., those which occupy the lower part of the thorax, the incision is made in the eighth intercostal space, just behind the posterior axillary line. Theoretical objection might be raised to this location by the fact that the ascent of the diaphragm, which occurs in the course of healing of every empyema, might cause a kinking of the drainage tube; but in practice this does not occur. Obviously when the empyema is localized in other portions of the thorax, the incision is made directly over its site and at its most dependent portion.

b. The incision of the extrapleural soft parts. The cutaneous incision should be of ample length (two to four inches, depending upon the amount of adipose tissue present), so that with proper retraction all subsequent steps can be carried out under the guidance of the eye. It is important to remember that the incision made, with the arm hyperadducted, will shift when the dependent position of the arm is restored. If this is not considered, the surgeon finds that his cutaneous incision is not in alignment with the pleural incision. This is a circumstance which is extremely annoying in the after-treatment, and may require a second incision at right angles to the first. It is readily obviated by outlining the incision while the arm is in the adducted position.

3. *The incision of the pleura.* In primary operations proper drainage is obtainable, in about 90 per cent of the cases by a simple intercostal incision of the pleura. This is one of the points wherein I differ from the usually accepted teachings, that resection of the rib is an absolute essential. I have not encountered in a single instance the frequently discussed and greatly feared compression of the drainage tube. In secondary empyemata, however, i.e., those in which one empyema cavity had already been drained, and the healing of which has caused a certain amount of approximation of the ribs, one to two inches of the lower rib exposed in the operation must be resected.

I am in favor of simple intercostal incision, because it is simple, takes little time, and especially because the drainage opening is just as ample as after rib resection. Furthermore, this procedure is seldom followed by necrosis of the ends of the divided rib, a not infrequent cause of persistent sinuses.

4. *Drainage material.* Drainage is made through a single large size rubber tube of rather a stiff quality, and about one foot long. The tube is forced through a tiny perforation in a piece of rubber dam, approximately four inches square, which is fixed to the tube with a thread at a distance from 2½ to 4 inches from its thoracic end, depending upon the thickness of the chest wall. Near the thoracic end one large fenestra is cut into the tube.

The pus is slowly evacuated. I do not irrigate the cavity upon the operating table, not from any fear of the irrigation, but in order not to prolong the operation unduly. If anything appears to be definitely settled in surgery, it is, that under no circumstances should an empyema cavity be irrigated; there is not a surgical textbook, which does not deal with definiteness regarding this point. Explanations are given for this definiteness, which, if critically analyzed, however, will be found not to explain at all. Personally I believe there is a fairly good reason for it, which, however, has not been recognized until now, namely, the frequently existing communications of the pleural cavity with the bronchial tree. As already stated, I do not irrigate the cavity upon the operating table for other reasons; as will be shown, however, I do so very soon thereafter.

The drainage tube is introduced into the thorax so that the fenestra is just inside. This must be gauged with some care, in order to permit the rubber dam to be flush with the skin. No sutures are ever employed, and the external incision is simply packed with gauze. After cleansing the skin, the rubber dam is laid smoothly upon it, and its edges firmly attached by broad strips of adhesive plaster. A dressing is so applied that the tube (temporarily clamped) finds free egress.

Upon reaching the ward a simple combination instillation and suction apparatus is attached to the drainage tube by means of a T tube; at a convenient point a second attachment is made for a bottle to receive the discharges escaping from the empyema cavity.

Once an hour, or more or less frequently as indicated, the syphon part of the apparatus is discontinued by clamping, and the instilling part of the apparatus, a Dakin container, is opened, and the requisite amount of solution is allowed to run in. After the lapse of five minutes the suction apparatus is reopened, and the solution plus secretions syphoned out. The suction is continued until the next period of instillation.

The advantages of this combination apparatus, consisting of drainage tube, instillation apparatus, suction apparatus, and receiving bottle, are the following:

1. All the discharges are collected into the receiving bottle, and in consequence the wound does not require any change of dressings. I usually avoid for one week or 10 days the dressing of patients connected with the apparatus.

2. The cavity is perfectly dry, and there being no retention of pus, fever does not arise.

3. An early opportunity is given to permit a prompt and efficient use of Dakin's solution.

4. The vacuum created aids to a limited extent in the expansion of the lung.

After-treatment. All patients are dressed only once in 24 hours. All the old dressings, including Carrel tubes and "safety valves" (to be subsequently described) are removed and are replaced by fresh ones. All rules as enunciated by Carrel for the preservation of a perfect asepsis are rigidly adhered to, except some trivial details, as will be mentioned.

After cleansing the skin with a dry cotton sponge, followed by a sponge moistened with alcohol, a soft rubber catheter (about 22 F.) is connected with a Dakin container, and is introduced into the empyema cavity. The cavity is thoroughly flushed, the patient being turned from the lateral to the prone position, and vice versa, until the return flow is perfectly clean.

From one to four Carrel tubes are now introduced into the cavity, the object being to distribute them into various portions of the cavity. In very long or irregular cavities we occasionally made use of tubes which were armed with a silver wire stylette. A short drainage tube, with one fenestra guarded by a safety pin, so-called "safety valve," is finally introduced, to permit a free escape of the Dakin solution and secretions.

Right here I might digress for a moment in order to mention, that the rationale of the entire postoperative treatment must be thoroughly understood. One must not fall into the error of thinking that there is something supernatural in Dakin's solution as far as the cure of an empyema is concerned. All that the Dakin's solution can do, or is expected to do, is to sterilize the cavity. This, however, it cannot do if the other surgical principles are neglected.

The vicinity of the wound is protected by sterile vaseline gauze strips. At a distance from the wound the skin is protected from irritation, by the application of a stiff zinc oxide ointment, which was found to be rather more efficacious in this respect than vaseline.

A few small fluffs of dry sterile gauze are placed next to the wound, and a more liberal use of reclaimed gauze, or absorbent cotton, completes the dressing, and is held in place by a firm binder. The Carrel tubes emerge on top of the binder, usually in the vicinity of the shoulder.

Definite instructions are given for the instillation of the requisite amount of Dakin's solution; the quantity depends upon the size of the cavity, and varies from 25 cubic centimeters to 100 cubic centimeters (in general about one-half of the volume of the cavity); it is distributed in equal amounts through all the tubes. Directions are also given as to the intervals between instillations; I have found hourly instillations to be most satisfactory.

The dressing is not touched for 24 hours. The quantities of Dakin's solution used saturate the dressings, but upon inquiry patients did not complain of this seemingly annoying drawback.

Cases which are complicated by pleuropulmonary fistulas, particularly those of large size, cannot be irrigated with large amounts of Dakin's solution, because of the very irritating cough which results from overdistention of the cavity; they tolerate, however, hourly instillations of the requisite amounts in perfect comfort.

Already at the first dressing the discharge has lost its frankly purulent character. Usually the cavity is perfectly dry, as all the discharges find egress through the "safety valve." It is almost marvelous to see the effect of a properly carried out treatment. All pus and odor disappear as if by magic.

In some of the cases of long standing, i.e., those in which the drainage was for a while imperfect, we had an opportunity to observe the character of the discharge. Its consistency was not unlike that of uncooked white of egg, in which there were enmeshed a few grayish or reddish particles. When sterilization became more complete, the discharge lost this appearance, and the irrigation was followed by small hæmorrhages. We interpreted the first finding as due to the liquefying action of the Dakin's solution upon the dense fibrinous deposit upon the pleura; and the hæmorrhages as due to irritation of pleural granulations.

It is most interesting to follow in cases recently operated upon the changes caused by the Dakin's solution upon the infected pleura. When an empyema is operated upon the pleura is found coated throughout by a soft grayish deposit of varying thickness composed of pus and fibrin. As sterilization proceeds, this coating disappears very rapidly, exposing a smooth glistening surface; particularly upon the pulmonary side, it is so thin, that the underlying lung tissue becomes readily visible and recognizable.

Twice a week smears and cultures are made from the cavity. When very low counts are obtained, these are made daily. When sterility is reached and is continued for several days, all tubes are left out and the Carrel-Dakin treatment is discontinued. Prompt and permanent healing is the result in many instances; in one case in 13 days.

In a few cases I have attempted a plastic closure of the fistulous opening, but the results attained did not warrant me in continuing this practice. Moreover I do not see any particular indication for doing so. If the cavity is not sterile a premature closure of the wound is sure to be followed by an infection, with subsequent breaking down of the suture line; if on the other hand it is sterile the wound closes so promptly, that even the trivial operation of refreshing the edges and suturing is uncalled for.

Considerable importance is ascribed by most surgeons to the use of blowing bottles in order to encourage the lung to expand. I will not deny that this device may help, but I have found that most patients, after the first enthusiasm of a new toy, discontinue its use. I have found more benefit in properly and systematically carried out light exercises; I encourage particularly light work around the wards, which keeps the patients interested and amused.

In the early part of my paper I have already emphasized the importance of keeping up the nutrition of the patients.

3. THE CHRONIC STAGE

In this group I would place only the following cases:

1. Cases which do not heal within a "reasonable" time.
2. Cases of recurrence within the old empyema cavity.
3. Cases, in which a second pus focus is discovered, at some distance from the original focus.
4. Cases of pus collections within the parenchyma of the lung.
5. Cases of bronchocutaneous fistulas.

1. *Cases which do not heal within a "reasonable time."* The word "reasonable" permits a wide latitude in its interpretation. My views regarding the manner in which an empyema heals have undergone a very radical change, since my experience in the military service. I conceived that healing occurred only by a process of obliteration of the pleural cavity, due to adhesions resulting from a granulomatous change in the pleura. Only when the entire affected pleural surfaces became adherent did the drainage opening close. When a cavity still persisted I observed that the opening showed no tendency to close.

Since this epidemic has been in existence I have been able to observe the following variations:

1. The far-reaching observations at the War Demonstration Hospital of the Rockefeller Institute have taught us that empyema cavities can be rendered bacteriologically sterile by means of the Carrel-Dakin treatment, and the drainage opening can then be closed by secondary suture. In a fair percentage of cases union with definite closure occurs. I am not aware that the progress of healing has as yet been described in detail by the originators of the method, but from personal observations, I have found that a certain amount of exudation occurs, though not to the full extent of the cavity. In the course of time this secondary exudate becomes absorbed, and is replaced by the slowly expanding and adhering lung.

2. In a few cases of healed empyema I have found on casual physical and X-ray examination, a very definite closed pneumothorax, usually at the site of the original empyema; in one case at some distance from it. I watched these cases with great care, and certainly also with fear, but found that the expected reaccumulation of pus did not occur; on the contrary, the cavity disappeared within about a month's time, the lung expanded and completely replaced the pneumothorax.

3. We also had the following very unusual experiences. Originally they were cases of empyema, which secreted large amounts of pus; when they came under my care, however, there existed only a small sinus, which led into a large cavity. The peculiarity of these cases lies in the fact that in spite of little treatment, these sinuses persisted for a long time, without any apparent discharge, or at most a few drops in the course of a week. Ultimately, however, these cases closed up completely, and remained closed to date.

4. Finally we have made the following observations. We have seen cases that were long under treatment with Dakin's solution. No hæmolytic streptococci were found for a long time. The cavities were X-rayed periodically, found to be smooth and simple, and while at the beginning a certain amount of concentric diminution was noted, these cavities finally remained stationary. In civil practice, such cases would indicate some variety of secondary operation. However, in view of the three possibilities just related, a chance was taken, and all treatment was discontinued. We were surprised to see such cases heal permanently.

It is seen, therefore, that in addition to the hitherto known, so to say, the classical method of the healing, there exist at least four other methods. It is on this account that I find difficulty in exactly defining the words "reasonable time." In general I would say that in the light of our present knowledge, I would exclude from this group simple cases, in which the pleura is smooth, in which the cavity is not of extreme size, and cases that are not complicated by side pockets or lateral sinuses; in other words, I would not include in this group any empyema cavity which is

amenable to treatment by the Carrel-Dakin method.

If we examine the cases which cannot be remedied by even long-continued treatment by the Carrel-Dakin method, we will find the following:

1. Cases which are complicated by large pleuropulmonary fistulas.
2. Cases with retained foreign bodies.
3. Cases with side pockets.
4. Cases with lateral branch sinuses.
5. Cases with necrotic ribs.

II. *Cases of recurrence within the old empyema cavity.* Broadly speaking these cases are always a reflection upon the surgeon in attendance, for it means that drainage and antiseptic treatment of the cavity have been discontinued prematurely. To my mind such cases are particularly liable to occur if the sinus or external incision is closed operatively, because not infrequently good judgment is supplanted by haste. Even the strictest precautions, such as smears and bacteriological cultures, do not always furnish a reliable guide to the presence or absence of microorganisms existing within the empyema cavity. It again only proves the absolute value of the well recognized axiom in medicine, that a negative proof is no proof. That it can occur also in those cases which have been allowed to close spontaneously, is well proven by the fact, that we encountered re-collections of fluid in eight of our cases. Six of these had definite collections of pus, containing streptococci; two were found to contain sterile serum. For simplicity's sake I have grouped them all under one heading, though it is evident that the last two were milder and simpler, and disappeared spontaneously.

III. *Cases in which a second pus focus is discovered at some distance from the original empyema.* In a previous portion of my paper I have already discussed the manner of formation of an empyema cavity. Occasionally encapsulation of the pus occurs elsewhere than in the supradiaphragmatic portion of the thorax, and as a result we may have two or more separate empyema cavities. At the time of the first operation usually only one, the larger and lower one, is opened. Sooner or later, however, it is noted, that the patient does not improve; and after physical and X-ray examination, sometimes even long after the main cavity is healed another pus focus is found. In only one case did we find that the second pus focus broke through into the primary cavity; usually it requires a second independent operation for drainage; their most frequent location was in front, overlying the apex of the lung, and toward the apex of the axilla.

Incidentally I may mention that at postmortem examinations, soon after my arrival at Camp Lee, we frequently encountered small encapsulated collections of pus, which were located behind the costal cartilages, approximately between the anterior sharp margin of the upper lobe and the mediastinum; but we have never seen such in any patient who survived.

IV. *Cases of pus collections within the parenchyma of the lung.* As already stated in a preceding portion of my paper, I am firmly convinced that most, if not all, cases of empyema have their origin in one or more small subpleurally situated pulmonary abscesses, which perforate into the pleural cavity. I do not refer to these at this point. I refer now to an encapsulated collection of pus within the parenchyma of the lung, not connecting with either the pleura or with a bronchus of appreciable size. In the former case it usually evacuates itself into the pleura, in the latter through a bronchus. The recognition of encapsulated abscesses of small size is very difficult on ordinary physical examination. Lately Lieutenant Stevens of the Empyema Commission has demonstrated by means of stereoscopic X-ray plates, that certain findings are quite characteristic of most pulmonary abscesses. These are the gradual formation of interstitial lung markings, usually definitely radiating throughout the lung tissue from the central focus of infection, and, if the abscess be near the periphery a corresponding thickening of the pleura over it. It is surprising that these abscesses are not encountered more frequently in the chronic stage; I believe this is due to the fact, that most of these patients succumb in the acute stage.

V. *Cases of bronchocutaneous fistulas.* Bronchocutaneous fistulas must not be confused

with the so frequently mentioned pleuropulmonary fistulas. Their etiology is of course the same, namely, a rupture of a subpleural pulmonary abscess. The difference between the two lies in the fact, that whereas pleuropulmonary fistulas are comparatively easy to cure (in fact not infrequently they close spontaneously), bronchocutaneous fistulas never close spontaneously, and usually require rather complicated procedures before a cure is obtained. The fistula usually communicates with a bronchus of some size. Their occurrence is readily explained by an adhesion of that part of the lung which bears the fistula; finally the mucous membrane of the bronchus grows outward and the cutaneous epithelium grows inward, until the two meet, and a so-called "lip fistula" forms. We have had cures in three cases of this nature.

The diagnosis of some of these conditions is self-evident; in others the diagnosis is exceedingly difficult. Constant care and attention is required to avoid numerous pitfalls and surprises. It is not within my domain to discuss the various physical signs; there is one point, however, which has struck me forcibly, and which I have not seen mentioned in any one of the reports published from various camps. It may be accepted as a proven fact that when a patient is healed and cured of his empyema, the cure is to all intents and purposes perfect. Such a cured patient feels well, he eats well, and he sleeps well; furthermore he has no fever, and he gains enormously in weight; in fact many of the patients not only attain their normal weight, but even go beyond it. In the presence of a slight evening rise of temperature, when accompanied by a loss of weight, one should not permit himself to be deluded with the erroneous and yet frequently prevailing idea, that the patient is suffering from a latent tuberculosis. We at least have not found tuberculosis in a single instance. When these symptoms are present a thorough physical examination is rigidly indicated. At some point in the thorax a suspicious area will be found, which upon aspiration will yield pus; when this abscess is evacuated all symptoms disappear promptly.

In draining cavities most important information can be obtained as regards their outline, extent, and volume by means of stereoscopic X-ray plates, after injection with some substance opaque to the rays. We have tried numerous substances, particularly sodium and potassium iodide, 15 per cent neutral thorium nitrate solution; barium; and finally have arrived at the conclusion, that when "properly used" bismuth subnitrate or subcarbonate gives the most satisfactory results. I have purposely availed myself of the expression "properly used" in discussing this phase of the subject, because in addition to the well known toxicity of bismuth salts, my co-worker upon the Commission, Lieutenant Stevens, found another very important drawback, namely, that in the form as originally used, i.e., a vaseline paste, it frequently failed to give a correct picture of the cavity. This is due to the fact that pastes, even if properly heated, congeal so rapidly during the process of injection, that the air contained in the cavity cannot be displaced outward, but is compressed into the uppermost part of the cavity, and forms an effective barrier to the proper filling of the cavity. On several occasions we found upon the operating table, instead of the expected short sinus, as outlined with bismuth paste, a sinus several inches longer. The inefficacy of bismuth pastes was clearly demonstrated upon the re-examination of several cases under our observation. Lieutenant Stevens found a solution of the problem by substituting sterilized cotton seed oil for the vaseline. A special report upon the subject is now in preparation; suffice it to say for the present, that since using this method we are no longer troubled by deceptive pictures. Incidentally I believe, that the danger of bismuth poisoning is thus not only minimized, but practically excluded, as the oil mixture escapes at once.

X-rays are particularly useful in exposing conditions in an empyema cavity the existence of which renders them difficult to sterilize with Dakin's solution. I refer especially to branch pockets, sinuses, and pleuropulmonary fistulas.

COMPLICATIONS OF EMPYEMA

The local complications of an empyema are readily recognized, and readily coped with. I maintain that an ordinary empyema has no

distant complications. Positive blood cultures in empyema are so exceptional that one is forced to the conclusion that complications which occur in the course of an empyema, such as endocarditis, pericarditis, joint infections, peritonitis, etc., are due not to the empyema, but to the pneumonia.

TREATMENT OF CHRONIC CASES

I have purposely entered into the minutest details in the description of the treatment of the acute stage of the disease, because I am convinced that if the directions given are carefully followed, chronic cases will occur less than we have been accustomed to meeting them, and if they do occur, their treatment will also be materially simplified. For the sake of completeness permit me to begin with those cases which I did not classify as chronic, but which custom has hitherto placed in such a category.

1. *Large empyema cavities.* It is difficult to connote what we mean by the term "large." We must recollect that extremely large cavities are always the result of a mistake; namely, a too early operation, because adhesions have not had time to form. Our experience has also led me to believe that even cavities of very large size, if properly treated, and for a sufficient length of time with Dakin's solution, will eventually diminish in size. I believe this diminution depends upon several factors; upon the elevation of the diaphragm; the approximation of the ribs to one another; and finally upon the solvent action of Dakin's solution upon the dense fibrous deposit which covers the visceral pleura, thereby permitting a re-expansion of the lung. If the cavity has diminished to its minimum as ascertained by means of measurements and X-ray, and has become stationary; and furthermore if the cavity has been sterile for a long time, a chance may be taken to permit a closure of the sinus, by simply discontinuing all treatment. If the outline of the cavity is so complicated that sterility is not obtainable one of the major operations is indicated. My own preference is for a simple Schede operation, resecting all of the ribs which form the roof of the cavity.

There are several minor points regarding this operation which are worthy of being alluded to. In contradistinction to similar cases in civil life, these patients are usually in the very best condition, and stand a general anæsthetic perfectly well; in fact their condition, even after the resection of 5 or 6 ribs, is so good that they insist on leaving their bed upon the day succeeding their operation. A single straight incision over the greatest diameter of the cavity usually gives ample exposure. I found some difficulty in my earlier cases in the after-treatment, when parts of ribs lying in front of the scapula were resected, because of the subsequent tendency of the scapula to cover the opening which has been made. Therefore, I have lately carried my incision backward between the internal scapular and vertebral lines. This made the operative procedure somewhat more tedious, but it rendered the postoperative treatment so much easier that I recommend this step very highly.

Some difficulty is encountered in excising the rib which has been resected at the first operation, on account of grotesque spur and ring formations, and fusions with the ribs on either side.

The intercostal tissues are ligated *en masse* at both ends; the intervening portions are excised. All ribs are resected subperiostally; all the tissues, particularly the greatly thickened parietal pleura, are excised. We had attempted in some cases, particularly favorable for the procedure, to excise the fibrous deposit covering the visceral pleura (Delorme), but contrary to our experience in civil life with pneumococcus empyema, we found it difficult to remove this deposit without causing excessive trauma to the underlying lung. Such trauma is undesirable because it prevents the early application of Dakin's solution. In a few cases I made criss cross incisions of the pleura (Ransohoff), but have not noted any marked inflation of the lungs. In another series of cases I have merely curetted the fibrous deposit, and believe that I have seen a more rapid formation of granulations.

The wound is simply packed, and no sutures are introduced. At the first dressing, from 4 to 6 days after operation, the tampons are

removed and treatment with Dakin's solution is carried out until final healing occurs.

2. *Treatment of chronic empyema sinuses.* The chronic empyema sinuses may be divided into two classes: (a) those that are sterile, and (b) those that are infected.

a. Sterile sinuses heal permanently upon discontinuing all treatment. Only in rare instances does a reaccumulation of pus or serum occur.

b. Infected sinuses. In the treatment of these it is absolutely necessary to find the reasons for the infection. The most frequent causes and their treatment are the following:

a. Accidentally lost foreign bodies such as sponges, drainage tubes, rubber dam, etc.

b. Necrotic ribs.

c. Branch sinuses and irregular side pockets of the main sinus, which can not be reached perfectly for an adequate treatment with Dakin's solution to permit sterilization; these usually require a Schede operation for a perfect exposure.

d. Pleuropulmonary fistulas. As already pointed out in a previous portion of my paper pleuropulmonary fistulas are very common; most of them are small and heal quite readily and spontaneously during the acute stage. If not they are usually of large size, and connect directly with a bronchus. The non-healing is due to two conditions: first, because the bronchial epithelium has grown outward and lines the termination of the channel; and second, because the mouth of the sinus is continually held open by the dense fibrous deposit upon the visceral pleura. Their treatment is rather difficult; I have succeeded in most cases with the following procedure. An adequate exposure of the mouth of the sinus is an absolute essential, and is readily obtained by means of a Schede operation. The lung is then very thoroughly mobilized at the margins of the cavity; a step which, in spite of the density of the adhesions, is quite readily done, and with some care without undue traumatization of the lung. This simple mobilization of the lung is, I believe, the most important part of the operation, as it allows of approximation and healing of the margins of the fistula. In a few cases I have excised a small wedge-shaped piece of the lung surrounding the fistula, and closed it by a few catgut sutures.

The primary dressing of these cases is very important. I lay considerable stress upon the fact that no gauze should come in contact with the fistula. I dress these cases by interposing between the fistula and the gauze a sterilized piece of rubber dam. In many cases I have found the fistula closed at the first dressing, 6 or 7 days later; if not, I employ dressings saturated with dichloramine-T.

3 and 4. *Pus collections at some distance from the original empyema and reaccumulations of pus in the original cavity* usually require costatectomy. An intercostal incision as in primary empyemata is insufficient, because the healing of the first empyema has caused too much approximation of the ribs for adequate drainage.

5. *The treatment of lung abscesses* opens up a chapter almost foreign to the theme under discussion; I shall mention only one important point, namely, that I believe that in these cases a simple adequate incision and drainage is sufficient, and that owing to the already existing massive adhesions between the visceral and parietal pleura, this is usually quite a simple procedure.

6. *The treatment of bronchocutaneous fistulas* is a somewhat more difficult procedure. It requires adequate mobilization of the lung, usually obtained by means of a Schede operation, followed by excision of entire fistulous tract, with or without subsequent suture.

The objectionable feature of the treatment of all cases complicated with a pulmonary fistula, except occasionally in the acute stage, arises from the fact that they do not permit of treatment with Dakin's solution for self-evident reasons. In these cases, at least until the fistulous portion has closed, I have used quite successfully dichloramine-T in small quantities, and have found it a good substitute, though not as satisfactory as Dakin's solution.

It is apparent that the subject of empyema is by no means as simple as it has hitherto been regarded. I have merely skimmed it superficially, but I shall feel that I have been amply repaid for the preparation of this paper, if I have stimulated further study of the many remaining unsolved problems.

EMPYEMA

Analysis of 70 Cases at Base Hospital, Camp Jackson, South Carolina

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As in many of the other cantonments so at our hospital the subject of empyema has been one of the important surgical conditions that has come up for consideration. Due to the frequency of its occurrence and its high mortality, it has attracted considerable attention and the interest manifested in it has been enhanced by the widely different results that have been reported. The rapidly fatal outcome following early operation on a number of patients showed us that we were apparently dealing with a condition somewhat different from what we had ordinarily considered empyema at home and that therefore different treatment was required. Upon investigating more carefully it was found that we were confronted with two different conditions, one an empyema following the usual lobar pneumonia, the other following secondary pneumonia. The object of this paper is to demonstrate that the widely different results obtained and the various opinions expressed are due to this difference in cases. We will show that those cases following a primary pneumonia, usually lobar in character, and caused by the pneumococcus, give results in the army hospitals as good as those obtained in civil life, while the empyema following secondary pneumonias is extremely severe and has a high mortality. We were not, as some people believed, dealing with a new disease, but with conditions that are less frequent in civil practice. For instance, measles which furnished a large number of pneumonias is rather infrequent in adult life under ordinary conditions, or at least we do not see any large number of cases at one time, but it is a common and severe disease in camp. Other diseases also, such as tonsillitis, bronchitis, and influenza are apt to be more virulent when occurring in epidemic form; they may be of streptococcic origin and the pneumonia following is often bilateral bronchopneumonia. It is these various groups that have furnished our severe empyema cases with a high mortality. Our ideas in regard to the treatment of empyema following primary lobar pneumonia have not undergone changes, but in regard to those following secondary pneumonia, we have been impressed with the influence of the antecedent disease on the course, and we have learned that the results obtained depend very much on the type of organism producing the infection and also on the procedure followed in treatment. Apparently there is a certain time when conservative methods should be followed and a period when radical surgical methods should be resorted to.

This paper is based on the study of 70 cases that have come to operation in the ten months, period from November 1, 1917, to September 1, 1918, up to about the time of the influenza epidemic, but not including any of the latter cases. The subject is presented from a surgical standpoint. No attempt will, therefore, be made to go into bacteriology or pathology in detail. During the early part of the period covered, our laboratory was in a stage of development and was overwhelmed with a meningococcus sepsis epidemic. As a result, bacteriological examinations of pneumonia and empyema cases were not made as frequently as is now the case. However, a positive finding is present in most of the cases and in the few in whom none was made, we have grouped a patient with the class of cases to whom he clinically corresponds.

The frequency of the disease in the different months of the period is illustrated by the accompanying chart, which shows it to be most common in the winter months when acute respiratory diseases are at their height (Chart 1).

ETIOLOGY

The statement is frequently made that men of the South are more prone to pneumonia and empyema than the Northerners, and again

that those from rural districts are more often affected than those from urban districts. In a given camp this statement is difficult to prove or disprove. Our troops, for instance, were nearly all from Southern States and had led an outdoor life. It is only by a comparative study of the statistics from various camps, available at the Surgeon General's Office, that definite conclusions in this respect can be drawn. Of our 70 cases, 64 or 91 per cent were from the Southern States and 52 or 74 per cent were farmers or laborers leading an outdoor life. Though many of our soldiers were former cotton mill workers, who in appearance were rather poor physical specimens, not one of our empyema patients was drawn from that class. The frequency of malaria and hookworm infection and the incidence of pellagra in the South have been cited as predisposing causes. Their rôle is a secondary one in that they lower the general resistance of the patient. Ten of our patients showed hookworm, though not all had their fæces examined, and two had malaria in a chronic form. It does not appear that the percentage of colored soldiers affected with empyema was higher than that of the whites. Of our 70 cases, 57 were white and 13 colored.

In considering the exciting causes it is found that pneumonia preceded the empyema in nearly every case. Many of them were primary lobar pneumonias, while the majority were secondary to some acute infectious condition.

These secondary pneumonias are divided as follows: 23 following measles; 7, bronchitis; 3, influenza; 2, tonsillitis; 1, otitis media; 1, meningitis; 1, abscess of cheek; 1, tonsillectomy; 1, following an anæsthetic; and 3 following typhoid inoculation.

The incidence of pneumonia following typhoid inoculations is of great interest. Patients usually state that they have had a cough, which became aggravated immediately after the injection. The relation between typhoid inoculations and acute respiratory diseases merits investigation.

We had only three cases that were originally diagnosed as pleurisy. Whether they developed a pneumonic process before going on to empyema formation is doubtful. In these

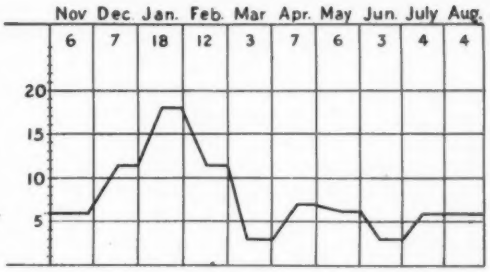

Chart 1.

cases the question may well be raised whether there was not some lung focus present that ruptured externally and produced the empyema. Upon going into the history of these so-called primary pleurisies it is found that they have not been well for some time, that they have had a cough and a cold in the chest.

Among either groups of the above-cited cases may be those with a general sepsis, in which the localization in one or both lungs and a subsequent empyema are but manifestations of a general septic process. Other parts of the body may likewise be affected and play an important rôle in the course of the disease, they may even be the more important factor.

TYPES OF EMPYEMA

If one sees a large number of these patients he is struck with the fact that they differ a great deal. Some correspond more to the type which we have been accustomed to see in civil life, others are of a degree of severity that leads to a fatal issue in a short time. The noticeable fact attracting attention in many of the patients is the early formation of large amounts of fluid. This fluid is usually thin, dishwater like and contains flocculi of fibrin. Because they differ in their course and prognosis and in order to facilitate study and to bring out the essential differences between the various types of empyema we have divided them into those following: (1) primary pneumonia, (2) measles pneumonia, (3) other secondary pneumonias, and (4) primary pleurisy.

Another classification based on the bacteriological findings, allows us to group them into those caused by the pneumococcus and those caused by the streptococcus. Other varieties

of organism we did not encounter in our 70 cases. In the final analysis this classification is the more important one because when looking over the entire series it is found that cases due to the pneumococcus, although more severe in those following a secondary than in those following a primary pneumonia, give about uniformly good results, while the prognosis in streptococcus infections is always grave and the complications many.

1. Empyema following primary lobar pneumonia. It is not always possible or at least not easy to differentiate strictly between primary and secondary pneumonia, because at the time when empyema and pneumonia are most frequent very many people have some respiratory affection. However, we have put into this class all those cases of lobar pneumonia that had a sudden onset though some of the patients may have had a cough preceding it. Table I given below embraces 24 cases. The process involved either one or several lobes or even both sides, in some cases simultaneously, in others successively. With the exception of two cases, one of which was due to the streptococcus, the other to a mixed infection, they were all caused by the pneumococcus.

It will be seen by looking over this table that fluid was usually found within two or three weeks after the onset of the pneumonia and that operation was performed as soon as the presence of pus was demonstrated. In five cases, 6, 8, 9, 16, and 20, the empyema was of the small encapsulated variety. This accounted for the late finding of pus in two of them. One patient had been returned to duty, Case 16, apparently well, and came back about three months after the onset of his pneumonia with a small encapsulated empyema, apparently interlobar in character.

Complications in this group have been few. There were three patients with an otitis media, Cases 3, 12, and 14. Two patients, Cases 12 and 23, had a parotitis that did not go on to suppuration. Pericarditis was diagnosed in Case 20 and was found at autopsy in Case 2. A few patients had superficial abscesses and one of them, Case 22, had a large abscess of the rectus abdominalis resembling a full bladder, and another one of the back. The former was sterile while the latter contained pneumococci.

Three cases of this group ended fatally: Case 15 had a positive blood culture of Type I pneumococcus. He died with symptoms suggesting meningitis. Case 18 died 11 days after the onset of his disease and one day after operation. During the latter, pockets were broken up with the aid of the finger, and it is possible that this had something to do with the fatal outcome. The fact that it occurred so soon after would indicate this. It certainly does not seem wise to carry on extensive manipulations when operating for empyema especially not early in the disease. An autopsy was not performed in these cases.

Case 2 died of a streptococcus sepsis 21 days after the onset of his pneumonia. Autopsy revealed consolidation of the entire left lung and an extensive pericarditis with serosanguinous effusion.

It may be stated that empyema following primary lobar pneumonia which attacks the patient while in good health, not weakened by antecedent disease, usually runs a shorter course than the other varieties. In the list given in Table I the average length of time from admission to the hospital until the patient returned to duty was 2 to 3 months. The few patients who were confined a long time had extensive secondary operations performed. They will be described in detail further on.

2. Empyema following measles pneumonia. These cases have been put into a class by themselves because they are usually very sick and the mortality is higher than in the other varieties. The group comprises 23 cases, 17 of which had a broncho and 6 a lobar pneumonia preceding the empyema. Thirteen cases were caused by the pneumococcus and ten by the streptococcus (Table II).

The complications in this group have been many and in a few cases they have contributed toward a fatal outcome. Ten patients developed a suppurative otitis media, two of them bilateral. We encountered several superficial abscesses and one deep abscess of the rectus abdominalis. There was one extensive cellulitis of the back taking its origin from the empyema wound, and another one of the neck leading to suppuration and rupture into the

pharynx. There was one patient with a peritonitis and one with a non-suppurative parotitis. Patient 35 deserves special mention. He was first taken sick on November 21, 1917, with mumps. On December 19, 1917, he developed measles and on the 22d a bilateral bronchopneumonia. The following day symptoms of meningitis manifested themselves. These two diseases, pneumonia and meningitis, then ran their course. For the latter he received intraspinal and intravenous injections as practiced at this camp leading to a complete cure. The pneumonia became complicated by a right sided empyema showing a pure culture of streptococci In spite of this he made a good recovery and was returned to duty, March 31, 4 months after the onset of the mumps.

The mortality was high, for in 9 patients, or 39 per cent, a fatal outcome is recorded. All of these cases had a bronchopneumonia, 6 due to the streptococcus and 3 due to pneumococcus. It will be noted that 6 of the patients who died were operated on early, from 2 to 9 days after the onset of the pneumonia. Of the 3 who died after a late operation, 2 had extensive lesions and really succumbed to a general sepsis. Those who died after an early operation died very promptly, one on the day of the operation, 3 on the following day, 1 two and 1 four days later. This to us has seemed of some significance and we have tried to discover the reasons for it, which will be considered somewhat in detail under treatment.

Case 42 had a double bronchopneumonia, left empyema, and pericarditis with effusion.

The course has usually been a long one for, regardless of the time following the onset of the measles or pneumonia, the average stay of patients in the hospital was 3½ to 4½ months.

Altogether it must be said that measles pneumonia is an extremely severe disease. Several of the patients had been discharged to duty after measles and were returned with a pneumonia. Others were sent on long journeys before they were well. The frequency of pneumonia in patients so treated would indicate that exposure has a great deal to do with its development after measles. To guard against it, therefore, and in order to prevent empyema, patients should be put to bed early. They should be kept warm and well protected and in the hospital long enough to be sure of complete cure.

3. Empyema following other secondary pneumonias. This group of 20 cases includes all those patients who developed empyema secondary to pneumonia following upon some other acute infection, aside from measles. Simple cough we have not considered as an etiological factor, but rather those conditions that made the patient sick and were then followed by a pneumonia. The reason is that the vitality of these people is frequently undermined and the pneumonia developing is more apt to be bronchopneumonia and frequently is bilateral.in character. Of this series fourteen followed lobar and 6 bronchopneumonia. Fourteen were due to the pneumococcus, 4 to the streptococcus, and 2 were mixed infections of both these types.

It will be seen in surveying Table III that the course of the disease varied considerably. Some patients recovered promptly, while others had a prolonged convalescence, necessitating a stay in the hospital of from 4 to 5 months. The complications were not many but they were extremely severe and contributed considerably to the fatal terminations. Of the four streptococcus cases the only one who recovered was one treated by repeated aspirations and late operation. Another one, Case 48, treated in the same way, was doing well and was apparently on the road to recovery when he developed a suppurative peritonitis and a general sepsis and died. Both patients with a mixed infection died. Of this series 7 cases ended fatally.

The autopsy records of 5 of them are given below:

CASE 50. Lobar pneumonia, bilateral, pleuritis right, 400 cubic centimeters of fluid; empyema left; old tuberculosis, right apex; luetic aortitis; luetic cirrhosis of liver; fibrous perisplenitis.

CASE 51. Empyema, right; cornification of right lung; numerous abscesses of body; acute endocarditis; infarcts of spleen, and infarcts of kidneys.

CASE 52. Pyopneumothorax, right; abscess right lung; pneumonia, right lung.

CASE 60. Lobar pneumonia, left; encapsulated pus pocket, left, due to perforation of lung abscess; empyema, left.

CASE 62. Empyema, right; pleurisy, left; pneumonia, left upper and right lower lobes; thrombosis, left lateral sinus.

4. Empyema following primary pleurisy. We had only 3 patients who can be put into this class. That a condition exists in which the pleural involvement is apparently the chief factor must be conceded. These 3 patients had not been well for some time before the intrathoracic condition assumed alarming proportions and made them seek medical aid. When they came under observation they were very sick and prostrated.

CASE 69 illustrates a type in which there is apparently first an involvement of the pleura and a secondary invasion of the lungs. Eight days after the onset of pleurisy and after a rather benign course, there was severe and extensive pulmonary involvement which in turn was followed by empyema.

CASE 70 was one of those who was prostrated early. He was admitted on the day of the acute onset, was cyanotic and dyspnœnic, and his chest was filled with thin turbid fluid. An immediate operation was deemed advisable and was performed. The course was extremely severe, an acute pneumothorax supervened, and a cellulitis spread from the edges of the wound, involving practically his entire trunk. The distress of the pneumothorax was somewhat alleviated by packing the opening from day to day. Whether in this case aspiration at first would have had the desired effect is questionable. He made a good recovery.

DIAGNOSIS

Though according to textbooks the detection of fluid in the thoracic cavity should be quite easy, it is by no means always that. It is by the careful examination of the chest, done daily and recorded on the chart that the presence of fluid is first suspected. By this systematic work, the variation in signs from the previous day or days will be noted. Displacements of the heart are of great value. By having had the patient under observation for some time, one is familiar with the organism causing the infection and can be on the lookout. It is important that the presence of large amounts of fluid be detected early and that it be submitted to bacteriological examination, because one is guided in the treatment largely by the laboratory findings. It is interesting with what rapidity the fluid sometimes develops. However, at times all physical signs fail, and it is familiar to those who do much of this work how deceptive signs may be. It is probably not putting it too strongly when we state that fluid in the chest may give the exact physical signs of a pneumonia and *vice versa*. Therefore when a suspicion of fluid exists, whether early in the disease or because the lung condition does not clear up as promptly as it should, one should never hesitate to use the aspirating needle. If properly introduced no harm can result. It should be of sufficient length and caliber and be introduced attached to the syringe with the piston pushed down. In this way the entrance of air is prevented. There is no place of selection for the exploration, it must be done wherever the fluid is suspected.

If these means fail, the X-ray has proved of great value, particularly in the smaller encapsulated varieties of empyema. In doubtful cases, therefore, an X-ray should be made, preferably a stereoscopic, and if a focus is found, exploratory puncture should be done under guidance of the plate. The fact that two of our patients, Cases 16 and 67, were sent to duty after their pneumonia and later returned for an encapsulated empyema might suggest that all pneumonia patients should be X-rayed before being discharged.

CLINICAL CONSIDERATIONS

In order to treat empyema intelligently and to get the best results it is essential that the physiology and the mechanics of respiration be understood. We must know what happens if a normal pleural cavity is incised and left open. A condition of so-called open pneumothorax will ensue which means air will enter from without and in time cause the lungs to collapse. In addition to that this now positive pressure in the pleura will force the mediastinum over to the other side and embarrass thereby not only the respiration, but also the circulation. It is for this reason that an open pneumothorax is so much feared on the battlefield.

Now these factors play a rôle and an important one, in the treatment of empyema. To appreciate this properly we must visualize to ourselves what an empyema really is. Is it to be considered a collection of pus only, the residue of an inflammatory process, in

other words, a simple abscess, or is it an exudation fluid accompanying an acute inflammation and existing simultaneously with it? The answer to this is that it may be either, at the time that we are called to see a patient and it is up to us to determine which it is, for on that depends the treatment. In the former case when it is simply an abscess of the pleura, surrounded by an abscess wall, the treatment is manifestly quite simple, for incision followed by evacuation of the pus will give prompt relief and no embarrassment of the respiration will ensue. On the other hand, if the fluid present is accompanying an active inflammatory process of the pleura and the underlying lung, the conditions are entirely different. No protective abscess wall has formed, no or few adhesions are present, and if such a thorax is opened we are confronted with all the dangers of an open pneumothorax. The fluid will, of course, be evacuated but its place is promptly taken by air, and this air, representing a positive pressure, will bring about collapse of the uninvolved lung and produce displacement of the mediastinum. The question then arises, how are we to apply this knowledge to the treatment of an individual case? In order to do that we must know certain other facts. Clinical observation and studies at the autopsy table have taught us that pneumococcus infections of the pleura have a tendency to form pus early and that this pus becomes walled off early. We further know that in a pneumococcus lobar pneumonia the pleural involvement is usually confined to the involved portion of the lung. In a pneumococcus bronchopneumonia the conditions are somewhat different but the general characteristics of the organism remain the same. In these cases, therefore, operation is indicated as soon as the presence of pus is demonstrated.

In streptococcus infection of the lung with secondary pleural involvement on the other hand conditions are different. The entire pleural layer, both visceral and parietal, often becomes involved very rapidly and a profuse exudation of serum takes place. There is no early tendency to walling off and no protective barriers have formed. This extensive involvement is partly due to the fact that many of the streptococcus pneumonias are secondary pneumonias, they are usually bronchopneumonias with various small foci scattered throughout the lung causing a secondary involvement of each overlying portion of the pleura. Suppuration of this fluid, meaning by that a change to actual pus, occurs rather late, often only after several weeks have passed. However, with the change of fluid to real pus protective barriers form and it is then safe to operate.

Aside from the danger of pneumothorax, there is one other very important factor that must constantly be borne in mind; namely, the condition of the lungs at the time that operation is contemplated. This applies to the lung of the infected side as well as that of the opposite side. These patients are all very sick and we must be careful not to do anything that will aggravate their condition. Opening a thorax while the pneumonia is still active will increase the strain on both the respiration and circulation. Here again there is a marked difference between the two varieties of infections. We know that pneumococcus lobar pneumonia usually runs a short course. When we are, therefore, called in to see such a case on the tenth or fourteenth day we know that the pneumonia has probably cleared up, and if pus is found we know it is safe to proceed with the operation. With a pneumococcus bronchopneumonia a little more care is necessary and it may be well at times to postpone the operation a few days, perhaps doing an aspiration in the meantime.

In the streptococcus pneumonias we usually find numerous foci of infection; one may clear up while another forms. Several lobes or even both sides may be affected simultaneously or successively. Opening such a thorax will diminish the patient's chance of recovery, for a pneumothorax will form as stated above, and there will be collapse of all uninvolved portions of the lung. And as frequently the other side is also partly involved we increase the strain instead of decreasing it.

What then can be done to benefit these patients, what is the correct procedure to give them the best chance for recovery? Unfortunately some of these patients seem doomed from the beginning; they are simply over-

come by the severity of the infection, and there is nothing known to us at present that will save them. The first temptation is to operate at once. As a matter of fact that was the procedure we followed at first until the promptly fatal results in a number of cases pointed that out as the wrong treatment. Heroics are apparently not in place with this work and it requires almost that to operate on patients in that condition. They are in great distress as a result of sepsis, the involvement of the lungs, the embarrassed circulation and the presence of the fluid. Operating on such a patient will release the septic fluid, but nothing else. It will not improve the lung condition or the circulation, quite the contrary, it will bring about the collapse of the uninvolved lung tissue on the affected side, and force the mediastinum over to the already overburdened other side. This to our mind accounts for the rapidly fatal results in some of the cases given in the tables.

The one object gained by operation, namely the removal of the fluid, can be obtained by aspiration without the dangers attending an early operation. This treatment suggested itself to us early in the period covered and though followed hesitatingly at first, we have gradually become more convinced of its efficiency and now apply it in all properly selected cases. Aspirations are repeated as often as indicated, sometimes only one or two are done, then again several, depending on the case. As soon as the fluid becomes suppurative, indicating thereby that adhesions are forming or have formed, and we feel reasonably sure that the pneumonia has subsided, we operate. No matter which organism is responsible for the infection, the aim should be not to operate while the pneumonia is active.

It is only when considering the accumulated amount of septic fluid in the chest as the principal factor in the disease that an early operation seems indicated. There are apparently those cases that are swamped with a streptococcus infection and its chief or only localization is in the pleural sac. In such a case removal of the fluid by early operation is perhaps the only chance a patient has, and one should go ahead fearlessly. However, even in these cases complete aspiration may produce as good results without the dangers attending an operation. It is a question whether the lung is ever involved in such a condition. Patient 70 belongs to this class. To prevent the pneumothorax one may use any one of the methods of closed bottle drainage. The great objection to them is that they are cumbersome, easily deranged, and contribute to the discomfort of the patient. During the early days after operation, however, a Brewer tube with a negative pressure bottle system does excellent service.

Though operation is delayed in the type of cases outlined above, one should not wait until a thickened pleura has formed, favoring chronic cavity formation later on. The old rule to evacuate pus as soon as formed applies here also. Each case must be judged on its own merits, there is no absolutely fixed rule, but the considerations outlined above should guide us to reach a decision in a given case. If called in therefore to see a patient with a view to operating we must come to a conclusion after considering his general appearance, his present temperature and pulse, the antecedent disease, the length of time since the onset of pneumonia, the type of fluid found and the organism producing the infection.

SURGICAL TREATMENT

It must be borne in mind that in a military hospital where changes in the staff are frequent it is difficult to control all details of treatment. However, a certain uniformity of opinion has prevailed, especially in regard to the time of operation.

In very sick patients we have done and continue to do an intercostal incision frequently in bed, and without removing the patient to the operating room. Novocaine in ½ per cent strength is used and the incision is made just long enough to allow the introduction of drainage tubes. Whenever the condition of the patient allows it, which is usually the case, he is taken to the operating room and rib resection is done. In only two patients has ether been used. All others were operated upon under local anæsthesia, using ½ per cent novocaine. We have used either one large fluted tube or a double drainage tube. There

seems to be no difference in the reaction or the result. The tubes should be just long enough to insure a free flow but not so long as to impinge against the lungs. A large pad and firm binder are applied and the patient is encouraged to rest on the operated side. We were not in the habit of washing out, but large masses of fibrin were removed at the time of operation. In the latter part of the period covered we began to use Dakin-Carrel treatment quite extensively and would introduce the tubes either at the time of operation or on the following day. In the wards we use Gatch bed frames which allow a Fowler position. They contribute greatly to the comfort of the patient. In the first days following an operation, we use morphine in sufficient amount to overcome the distress and severe dyspnœa. There is one complete dressing a day at which time the cavity is irrigated and the tubes cleaned or changed. Outer pads are changed as necessary. At the time of dressing the patient's back also receives attention, his skin is thoroughly cleaned and an alcohol rub given.

In regard to the use of antiseptic solutions, we have used everything from normal saline, boric acid, cherry red iodine, and peroxide, to Dakin's solution. When looking over our entire series it is impossible to state truthfully that any one method has yielded uniformly good results. Dakin treatment was used faithfully, and in the hands of men taught at the Rockefeller Institute. In some cases it was used early, beginning on the day of operation. In the older cases later, to help clean them up. We obtained very good results in some cases but had equally good results in some parallel cases, in which nothing but simple drainage was used. Any very striking results showing marked superiority over other methods were not observed. Two of the cases treated with Dakin solution and closed with secondary suture when the wound was apparently sterile, had to be reopened. Attention must be called to the fact that though the cavity does apparently become sterile, as evidenced by a clear mucoid discharge, pus may be situated in some dependent portion of the cavity, and the irrigating fluid is prevented from acting on it by the presence of this mucoid covering. It is, therefore, important that the position of the patient be changed from time to time, especially that it is changed during the irrigation. All patients operated upon since September 1, 1918, have at once been put on Dakin treatment and it is being continued until a cure is obtained. None of those cases are included in this series. They will be reported upon at a later date.

From our observations the most important points in the treatment, both in order to get a cure and to get an early cure are to drain at the most dependent part in order to prevent collections of pus from forming and to keep this drainage opening sufficiently wide to allow free drainage. As healing progresses not the caliber of the tube, but rather its length, should be reduced, for this very reason, viz.: to get good drainage, a rib resection is preferable to an intercostal incision.

It is also important to encourage deep breathing and light arm exercise. To prevent reinfection of the cavity the fistulous opening and the surrounding skin must be kept scrupulously clean. An occasional application of iodine to the former is of benefit.

The length of time from the onset of pneumonia to the discharge of the patient or from the time of the operation until the wound was closed varied so much that no clue was found which would guide us to get a uniformly good result in a very short time. So many factors enter in and materially influence the course of the disease.

As will be noted from a perusal of the attached tables, the duration of the disease was usually shortest in those cases of empyema following primary lobar pneumonia of pneumococcus origin.

The remarks about treatment are incomplete without calling attention to the importance of diet. The patients are usually in poor physical condition when they come to the surgeon and their emaciation increases rapidly as suppuration continues. We have been very fortunate in having the full cooperation of the administrative personnel in the treatment of these patients. Anything that was procurable has been obtained for them. In addition to their regular meals they

would receive milk, raw eggs, etc., at two hour intervals and in that way we have succeeded in keeping up their strength to enable them better to overcome the infection.

All empyema patients are kept in a special ward or wards depending on the number in the hospital at any one time. They occupy beds on the sunny side in order to have the benefit of the sunlight. The temperature is kept comfortable, we do not believe that very cold air is of benefit. As soon as we feel it is safe for the patients to be up, we encourage them to sit up in a chair for a short time every day. By means of the Gatch springs they have become accustomed to the sitting posture and the transition from that to out of bed is easy for them.

SECONDARY OPERATIONS

In empyema one is by no means always dealing with a single cavity and the main cavity may have several smaller pockets communicating with it. With the existing tendency to walling off, one of these pockets may become partially or entirely shut off from the main cavity. Such a condition is favored by inadequate drainage. We have repeatedly observed secondary pus pockets break spontaneously and empty through the thoracic fistula. In other cases we have aided such a rupture by the introduction of a dressing forceps. In some cases it became necessary to enlarge the drainage opening by simple stretching, and in four patients, Cases, 53, 57, 64, and 13, in whom a primary intercostal incision had been done, a secondary rib resection had to be performed.

In one case, No. 10, who had a persistent fistula leading to a deep seated small cavity, we resected two ribs under local anæsthesia, mobilized the lung, excised the fistula, and cleaned out the cavity. Immediate Dakin treatment was started, flushing the wound every two hours. After a week the tubing was removed and the cavity allowed to close. There was no communication with a bronchus and the treatment was well borne.

In three cases we had to do an extensive rib resection with decortication of the lung. On account of the interest attaching to the condition we shall report them in detail.

Case 5 was first operated upon October 21, 1917, a part of the eighth rib being resected. On account of profuse drainage which did not diminish, he was again operated upon January 28, 1918, and the seventh and eighth ribs were resected for the greater part of their length. The thickened pleura was incised in several places to allow expansion of the lung. The patient's condition was so poor that extensive decortication could not be done. The drainage diminished but did not cease; therefore a counter incision was made anteriorly February 4, 1918. He improved considerably, but as he complained of pain in the chest and did not gain as rapidly as he should, an X-ray was made. It revealed an encapsulated empyema higher up. This was drained on April 2, by resecting part of the fifth rib anteriorly. Recovery was uneventful after that. He returned to duty, July 16, 1918.

The importance of the X-ray in the diagnosis of empyema was not fully appreciated by us in the beginning. It is now used by us not only in the original diagnosis whenever doubt exists or we want to localize a pocket exactly, but it is also used to follow up the case after operation. Whenever a patient is not doing well and physical signs fail, we resort to the X-ray, with most gratifying results.

Case 68. An intercostal incision was made for empyema on October 21, 1917. Drainage continued profuse, therefore the cavity was injected with bismuth and an X-ray plate was made. It showed a cavity reaching upward to the supraclavicular space. Operation January 9, 1918: resection of six inches of the eighth, seventh, sixth, fifth and fourth ribs and 1 inch of the third rib. The thickened pleura and intercostal tissues were divided and the pleura stripped off. The visceral layer of the pleura was then stripped off the lung and the pericardium carrying this dissection upward to remove the dome of the cavity. The lung expanded at once. Reaction was good. The cavity was closed February 27, 1918, and the patient returned to duty March 16, 1918.

Case 17. Operation was done October 24, 1917, for right empyema. An intercostal incision was made. The patient was extremely ill. During the course of his disease he developed an acute necrosis of both superior maxillæ. The entire bony alveolar processes were cast off in a short time, leaving an opening into the antrum on either side. The intermaxillary bone did not slough away and was later used for the attachment of a plate. The empyema showed no tendency to heal. Bismuth paste injection revealed a rigid cavity extending upward to the clavicle. Operation January 24, 1918, through large curved flap incision. The skin, pectoralis major and minor, were pushed upward, and the ribs exposed. About 4 inches of the fifth and fourth ribs, 3 inches of the third, and 1 inch of the second rib were then resected. The thickened parietal pleura and intercostal muscles forming the anterior wall of the cavity were divided. The pleura which in parts was ¼ inch thick, was removed. The visceral pleura was then stripped off the lung, which

expanded as soon as released. A small gauze strip was inserted into the cavity and the wound was then closed. The patient reacted well. After operation there was some bloody, frothy expectoration, but no other untoward result. Convalescence was slow. He was returned to duty, June 21, 1918.

There was only one lung abscess in this entire series that came to operation. He deserves mention.

CASE 24. The diagnosis was made by puncture, obtaining the same foul-smelling material which he was expectorating. It was confirmed by the X-ray. The odor was so offensive that isolation became necessary. The abscess was secondary to lobar pneumonia, due to pneumococcus type 2, which began 14 days before the abscess was recognized. The exploring needle withdrew air and foul-smelling, thick pus. The X-ray showed a lobulated cavity of the upper portion of the right lower lobe, surrounded by an area of infiltrations. Operation July 13, 1918: resection of 3 inches of the seventh and eighth ribs under local anæsthesia. Parietal pleura separated from chest wall to mobilize it. Exploratory punctures were then done and when the abscess was entered the needle was left in place. A circular silk suture was then inserted at a distance of 1 inch from the needle, suturing the visceral to the parietal pleura. A narrow bladed knife was then placed alongside the needle into the cavity and the opening widened so soon as pus was obtained. After cleaning out the cavity a gauze strip and rubber tube were inserted and another gauze strip was placed between the chest wall and the parietal pleura in order to keep them separated.

Recovery was uneventful. Dakin treatment was not borne well on account of a communication between the cavity and a bronchus. Iodoform gauze was, therefore, used in packing. The patient improved rapidly as the discharge diminished. It became necessary later to remove the silk suture. Recovery was complete and the patient was returned to duty November 13, 1918.

PROGNOSIS AND FINAL RESULTS

Enough has been said in the presentation of the various groups to indicate that empyema is a serious condition and that its development after pneumonia requires thorough study before operation is resorted to. This is especially true of the streptococcus infections. The patients are usually in poor condition as the result of the preceding infection and their resistence is low, so that any additional strain may determine a fatal outcome. Some patients seem simply doomed from the beginning and any measures known to us at present are without avail. We must, therefore, be very careful not to do anything that will diminish their chances of recovery.

It should be borne in mind, however, that though some of the deaths are attributed to empyema, because it was the condition for which the patient was operated upon, other lesions of a general sepsis or the lung condition itself was really more responsible.

Taking the various groups once more and studying them in relation to the final results, we find there were:

Following primary pneumonia 24 cases with 3 deaths, or 12 per cent;

Following measles pneumonia, 23 cases with 9 deaths, or 39 per cent;

Following other secondary pneumonias, 20 cases with 7 deaths, or 35 per cent;

Following primary pleurisy 3 cases with no deaths.

If we classify the cases according to the organism producing the infection, instead of according to antecedent disease, we find that there were:

54 pneumococcus cases with 9 deaths, or 17 per cent;

16 streptococcus cases with 10 deaths, or 62 per cent.

Taking our total of 70 cases, we find that there were:

19 deaths or 27 per cent, 48 cured or 69 per cent, and 3 in the hospital, or 4 per cent.

The three patients remaining in the hospital are doing well and promise to go on to complete recovery, so that the total will be 73 per cent cured.

All patients listed as cured have been returned to duty. This includes those patients with extensive rib resection.

TABLE I.—CASES OF EMPYEMA FOLLOWING PRIMARY LOBAR PNEUMONIA

Name	Race	Onset of Pneumonia	Organism	Aspirations	Operation	Side	Type Fluid	Time since Onset	Result	Total Time
1. B., A.	W.	Jan. 8	Pneum.	Jan. 19	Jan. 19	L.	Pus	11 days	Cured, duty Mar. 19	2½ mos.
2. B., J. H.	W.	Jan. 25	Strept.	Feb. 1–260 ccm. Feb. 2–300 ccm. Feb. 3–480 ccm. Feb. 6–pus	Feb. 9	L.	Thin pus	15 days	Died, Feb. 15	21 days
3. B., T.	W.	Dec. 10	Pneum.	Dec. 26	Dec. 28	R.	Pus	18 days	Cured, duty Mar. 15	3 mos.
4. C., L.	W.	Jan. 4	Pneum.	Jan. 10	Jan. 10	R.	Pus	6 days	Cured, duty Mar. 16	2½ mos.
5. C., E. R.	W.	Oct. 6	Pneum.	Oct. 21	Oct. 21	R.	Pus	15 days	Cured, duty July 16	9½ mos.
6. D., D. E.	W.	Jan. 16	Pneum.	Feb. 2	Feb. 2	R.	Pus	17 days	Cured, duty Apr. 12	3 mos.
7. D., M.	C.	Aug. 8	Pneum.	Aug. 17–30 ccm. serous Aug. 20–70 ccm. serofibrinous	Aug. 22	R.	Pus	16 days	Doing well in hospital	
8. F., A.	C.	Aug. 14	Pneum.	Sept. 8	Sept. 8	R.	Pus	25 days	Cured, duty Nov. 3	2 mos.
9. H., W.	W.	July 18	Pneum.	July 25–1 ccm. sanguinous July 28–5 ccm. sanguinous Aug. 7–pus	Aug. 7	R.	Pus	20 days	Cured, duty Nov. 13	4 mos.
10. J., A.	C.	May 16	Pneum.	May 21–35 ccm. turbid fluid May 27–350 ccm. pus	May 27	L.	Pus	11 days	Doing well in hospital	
11. L., B.	C.	Aug. 22	Pneum.	Aug. 28–60 ccm. sl. purulent	Aug. 30	L.	Pus thin	8 days	Cured, duty Nov. 16	3 mos.
12. M., R. F.	W.	Dec. 4	Pneum.	Feb. 3	Feb. 6	R.	Pus	33 days	Cured, duty Mar. 26	3½ mos.
13. N., B.	W.	May 4	Pneum. and Strept.	May 10–50 ccm. turbid	May 12	L.	Pus	8 days	Doing well in hospital	
14. O., C.	W.	Jan. 18	Pneum.	Feb. 5–280 ccm. pus Feb. 8–pus	Feb. 9	L.	Pus	22 days	Cured, duty Mar. 19	2 mos.
15. O'N., B.	C.	Mar. 9	Pneum.	Mar. 18–serous Mar. 26–pus	Mar. 26	R.	Pus	17 days	Died, April 1	23 days
16. P., W	W.	Apr. 6	Pneum.	July 6	July 18	R.	Pus	3½ mos.	Cured, duty Oct. 15	6 mos.
17. R., W.	W.	Sept. 25	Pneum.	Oct. 25	Oct. 24	R.	Pus	29 days	Cured, duty June 21	9 mos.
18. R., W.	C.	May 8	Pneum.	May 18	May 18	R.	Pus	10 days	Died, May 19	11 days
19. S., E.	W.	Dec. 16	Pneum.	Dec. 26–750 ccm. pus	Dec. 27	R.	Pus	11 days	Cured, duty Mar. 15	3 mos.
20. S., D.	W.	Dec. 7	Pneum.	Dec. 13–200 ccm. seropurulent Jan. 18–pus	Jan. 19	R.	Pus	43 days	Cured, duty Mar. 15	3 mos.
21. S., E.	W.	Apr. 16	Pneum.	Apr. 20–clear Apr. 22–clear Apr. 23–280 ccm. turbid fluid	Apr. 28	R.	Pus	12 days	Cured, duty June 8	7 weeks
22. W., D.	C.	Nov. 5	Pneum.	Nov. 23	Nov. 23	R.	Pus	18 days	Cured, duty July 26	8 mos.

TABLE I.—CASES OF EMPYEMA FOLLOWING PRIMARY LOBAR PNEUMONIA—*Continued*

Name	Race	Onset of Pneumonia	Organism	Aspirations	Operation	Side	Type Fluid	Time since Onset	Result	Total Time
23. W., J.	W.	Dec. 22	Pneum.	Dec. 31–30 ccm. Jan. 1–30 ccm. Jan. 4–250 ccm. serosanguinous Jan. 8–460 ccm. pus	Jan. 11	L.	Pus	20 days	Cured, duty Mar. 6	2½ mos.
24. K., W.	W.	June 22	Pneum.	July 12–foul pus	July 13	R.	Pus	21 days	Cured, duty Nov. 13	4½ mos.

TABLE II.—CASES OF EMPYEMA FOLLOWING MEASLES PNEUMONIA

Name	Race	Onset of Measles	Onset of Pneumonia	Type	Organism	Aspirations	Operation	Side	Type of Fluid	Time since Onset Pneumonia	Complications	Cavity closed	Result
25. A., J. W.	W.	Dec. 1	Dec. 24	Bron.	Strept.	Dec. 26	Dec. 26	L.	Pus	3 days?	general cachexia		Died, Dec. 27
26. A., W. G.	W.	Jan. 7	Jan. 14	Lobar	Pneum.	Jan. 22 — pus	Jan. 24	R.	Pus	10 days	Otitis media	Apr. 6	Cured, duty Apr. 18
27. A., H.B.	W.	May 6	June 3	Bron.	Strept.	June 5—15 ccm. cloudy fluid	June 5	L.	Thin pus 150 ccm.	2 days	Otitis media	Nov. 1	In hosp. doing well
28. C., H. M.	W.	Nov. 17	Dec. 7	Bron.	Pneum.	Dec. 11 — clear fluid Jan. 3 — pus	Jan. 3	R.	Pus	27 days	None	Feb. 18	Cured, duty Mar. 5
29. C., J. C.	W.	Dec. 3	Dec. 21	Bron.	Strept.	Jan. 1—540 ccm. thin purulent fluid	Jan. 4	R.	Pus	14 days	Otitis media. Suppurative perilaryngitis and tracheitis		Died, Jan. 12
30. C., J. W.	W.	Jan. 15	Feb. 1 Apr. 9	Bron. Bron.	Pneum. Pneum.	April 13 — clear April 14 — 1100 ccm. thin turbid	Apr. 14	R.	Thin pus	5 days	Otitis media Acute nephritis		Died, Apr. 18
31. D., W.	W.	Nov. 12	Dec. 1	Bron.	Pneum.	Dec. 6—thin pus Dec. 12—thick pus	Dec. 14	R.	Pus	14 days	Otitis media	Feb. 15	Cured, duty Feb. 19
32. D., L. A.	W.	Nov. 15	Dec. 3	Lobar	Pneum.	Dec. 12 — pus	Dec. 15	L.	Pus	12 days	Otitis media	Feb. 18	Cured, duty Mar. 15
33. G., H.	C.	Apr. 24	May 24	Lobar	Pneum.	May 29 — cloudy fluid July 7 — 30 ccm. pus	July 7	L.	Pus	44 days	None	Aug. 29	Cured, duty Sept. 20
34. H., W. A.	W.	Oct. 24	Nov. 14	Bron.	Strept.	Nov. 30 — 600 ccm. sero-purulent	Dec. 2	R.	Sero-purulent	18 days	Otitis media		Died, Dec. 4
35. H., C.	W.	Dec. 19	Dec. 22	Bron.	Strept.	Jan. 6 — serous fluid Feb. 25 — pyopneumothorax	Feb. 26	R.	Pus	35 days	Meningococcus meningitis. Multiple joint swellings	Mar. 28	Cured, duty Mar. 31
36. J., W.	W.	Dec. 18	Dec. 27	Bron.	Strept.	Jan. 18 — purulent 100 ccm. fluid. Jan. 27 — pyopneumothorax	Jan. 27	R.	Pus	31 days	Otitis media bil. Abscess rectus abd. Abscess olecranon.	Mar. 13 Mar. 13	Cured, duty Mar. 19
37. K., T.	W.	Nov. 30	Dec. 15	Lobar	Pneum.	Dec. 27 — thin pus Dec. 29 — pus	Dec. 30	L.	Pus	15 days	None	Apr. 17	Cured, duty Apr. 18

TABLE II.—CASES OF EMPYEMA FOLLOWING MEASLES PNEUMONIA—*Continued*

Name	Race	Onset of Measles	Onset of Pneumonia	Type	Organism	Aspirations	Operation	Side	Type of Fluid	Time since Onset Pneumonia	Complications	Cavity closed	Result
38. O., B.	W.	Jan. 14	Feb. 2	Bron.	Pneum.	Feb. 22 — straw colored fluid Feb. 26 — pyo-pneumothorax	Feb. 26	R.	Pus	24 days	Otitis media, bil. Abscess of toe. Cellulitis of back. Peritonitis (?). General sepsis.		Died, March 6
39. P., H.	W.	Nov. 2	Nov. 11	Bron.	Strept.	Nov. 19	Nov. 19	R.	Thin pus	8 days	None		Died, Nov.21
40. P., L. E.	W.	Nov. 13	Nov. 20	Bron.	Strept.	Nov. 22	Nov. 22	R.	Thin pus	2 days	None		Died, Nov.23
41. P., J. E.	W.	Nov. 21	Dec. 1	Bron.	Strept.?	Dec. 23 — serous fluid	Jan. 9	R.	Pus	39 days	None	Mar. 23	Cured, duty Mar.26
42. P., A.	W.	Jan. 25	Feb. 5	Bron.	Strept.	Feb. 13 — cloudy fluid Feb. 14 — 350 ccm. cloudy fluid	Feb. 14	R.	Cloudy fluid	9 days	Abdominal distention		Died, Feb. 15
43. R., S. A.	W.	Nov. 15	Nov. 29	Bron.	Pneum.	Dec. 6 — 500 ccm. serous fluid	Jan. 15	L.	Pus	47 days	None	Mar. 7	Cured, duty Mar.10
44. T., J. G.	W.	May 4	May 14	Bron.	Pneum.	May 18	May 18	L.	Pus	4 days	Otitis media		Died, May 18
45. V. A., T. B.	W.	Nov. 8	Dec. 1	Bron.	Pneum.	Jan. 24 — pus	Jan. 28	L.	Pus	58 days	Parotitis, non-suppurative	Mar. 1	Cured, duty Mar. 9
46. W., H.W.	W.	Nov. 15	Nov. 26	Lobar	Pneum.	Dec. 26 — pus	Jan. 3	L.	Pus	38 days	None	Feb. 25	Cured, duty Mar. 5
47. W., A. L.	W.	Nov. 28	Dec. 19	Lobar	Pneum.	Jan. 15—240 ccm. Jan. 16—150 ccm. seropurulent	Jan. 19	L.	Pus	31 days	None	Mar. 20	Cured, duty Mar.28

TABLE III.—CASES OF EMPYEMA FOLLOWING OTHER SECONDARY PNEUMONIAS

Name	Race	Antecedent Disease	Onset of Pneumonia	Type	Organism	Aspirations	Operation	Side	Type of Fluid	Time since Onset Pneumonia	Complications	Result
48. G., G.	W.	Influenza	Feb. 1	Lobar	Strept.	Feb. 5—340 ccm. ser. Feb. 6—300 ccm. ser. Feb. 8—830 ccm. ser. Feb. 15—160 ccm. ser. Feb. 23—pus	Feb. 23	L.	Pus	22 days	Peritonitis	Died, March 24
49. L., B.	W.	Influenza	Jan. 28	Lobar	Strept.	Jan. 29—185 ccm. ser. Feb. 1—180 ccm. ser. Feb. 3—450 ccm. ser. Feb. 6—280 ccm. turb. Feb. 8—560 ccm. turb. Feb 12—440 ccm. pus	Feb. 13	R.	Pus	16 days	None	Cured, duty June 15
50. W., P. W.	W.	Influenza	May 10	Lobar	Pneum.	May 15—cloudy fluid May 16—cloudy fluid	May 19	L.	Pus	9 days	Bilateral involvement	Died, May 24
51. A., H. A.	W.	Bronchitis	Jan. 8	Bron.	Strept. and Pneum.	Jan. 30—serous fluid Feb. 2—800 ccm. bloody fluid	Feb. 5	R.	900 ccm. bloody fluid	28 days	Parotitis supp. l. Multiple joint involvement. Phlebitis l. femur. Cellulitis of neck.	Died, Feb. 15
52. H., C. H.	W.	Bronchitis	Jan. 1	Bron.	Strept.	Jan 15—thin pus	Jan. 15	R.	Thin pus	4 days	None	Died, Jan. 25

TABLE III.—CASES OF EMPYEMA FOLLOWING OTHER SECONDARY PNEUMONIAS—*Continued*

Name	Race	Antecedent Disease	Onset of Pneumonia	Type	Organism	Aspirations	Operation	Side	Type of Fluid	Time since Onset Pneumonia	Complications	Result
53. J., R. C.	W.	Bonchitis	Dec. 16	Bron.	Pneum.	Jan. 14—serous fluid Jan. 20—pus	Jan. 30	R.	Pus	14 days	None	Cured, duty Apr. 20
54. M., H. G.	W.	Bronchitis	Dec. 29	Lobar	Pneum.	Jan. 4—10 ccm. bloody Jan. 10—250 ccm. seropurulent Jan. 13—pus	Jan. 28	L.	Pus	30 days	None	Cured, Mar. 19
55. McC., O.	W.	Bronchitis	Mar. 21	Lobar	Pneum.	Mar. 23—cloudy fluid Mar. 25—cloudy fluid	Mar. 25	R.	Sanguinous fluid	4 days	Erysipelas face	Cured, duty May 15
56. O., H.	C.	Bronchitis	Mar. 28	Lobar	Pneum.	April 19—pus	Apr. 19	R.	Pus	22 days	None	Cured, duty Aug. 14
57. P., G.	C.	Bronchitis	Jan. 18	Lobar	Pneum.	Jan 30—pus	Jan. 30	R.	Pus	12 days	Bronchial fistula	Cured, duty July 28
58. McC., J.	W.	Tonsillitis	Dec. 8	Lobar	Pneum.	Dec. 26—Pus	Jan. 2	R.	Pus	25 days	None	Cured, duty Apr. 18
59. P., C. T.	W.	Tonsillitis	Apr. 23	Lobar	Pneum.	April 25—serous April 28—pus	Apr. 28	R.	Pus	5 days	None	Cured, duty June 3
60. G., McC.	W.	Tonsillectomy	Jan. 30	Bron.	Strept.	Feb. 2—serous fluid Feb. 5—700 ccm. ser. Feb. 6—560 ccm. ser. Feb. 10—250 ccm. turbid	Feb. 13	L.	Thin turbid fluid	14 days	Pericarditis Pneumothorax	Died, Feb. 26
61. D., A.	C.	Abscess of cheek	June 7	Lobar	Pneum.	June 22—25 ccm. thin pus	June 22	R.	Thin pus	15 days	None	Cured, duty Sept. 21
62. M., B.	W.	Otitis media and mastoid	Apr. 2	Lobar	Strept. and Pneum.	April 8—bloody serum	Apr. 8	R.	Bloody serum	6 days	Mastoid, thrombosis, lateral sinus	Died, April 9
63. R., V.	C.	Anæsthesia	Mar. 8	Lobar	Pneum.	Mar. 27—turbid fluid	Mar. 27	R.	Thin pus	19 days	None	Cured, duty July 26
64. J., E.	W.	Meningitis	Apr. 17	Lobar	Pneum.	Apr. 20—30 ccm. ser. Apr. 29—pyopneumothorax	Apr. 30	R.	Pus	13 days	None	Cured, duty Aug. 20
65. D., F.	W.	Antityphoid Inoculation	May 17	Bron.	Pneum.	May 18—thin pus	May 18	L.	Thin pus	1 day	Pericarditis	Died, May 20
66. H., E.	W.	Antityphoid Inoculation	Apr. 18	Bron.	Pneum.	Apr. 19—600 ccm. cloudy fluid Apr. 20—1250 ccm. cloudy fluid	Apr. 21	R.	Thin pus	3 days	Pericarditis, dry	Cured, duty Aug. 16
67. W., H.	C.	Antityphoid Inoculation	June 4	Lobar	Pneum.	July 12—pus	July 13	R.	Pus	9 days	None	Cured, duty Aug. 19

TABLE IV.—EMPYEMA FOLLOWING PRIMARY PLEURISY

Name	Race	Onset	Aspirations	Operation	Type fluid	Side	Organism	Result
68. D., H. B.	W.	Oct. 18	Oct. 21 — pus	Oct. 21	Pus	L.	Pneumococcus?	Cured, duty Mar. 16
69. R., R. M.	W.	May 8	June 2 — cloudy fluid June 17 — pyo-pneumothorax	June 17	Pus	R.	Pneumococcus	Cured, duty Nov. 14
70. V., G. E.	W.	Feb. 12	Feb. 13 — turbid fluid	Feb. 13	Turbid fluid	R.	Streptococcus	Cured, duty May 4

A REVIEW OF THE TREATMENT OF PURULENT PLEURITIS (EMPYEMA) AT CAMP PIKE BASE HOSPITAL

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THE following report is based on an experience of nine months in the treatment of purulent pleuritis, embracing the months of March to December, and includes 147 cases. It covers not only three seasons which are of importance in discussing this condition, but also includes the pleuritis following three distinct types of primary infection, which are even more important, namely, influenza followed by hæmolytic streptococcus or pneumococcus pneumonia, measles followed by hæmolytic streptococcus or pneumococcus pneumonia, or primary lobar or bronchopneumonia caused by the pneumococcus or hæmolytic streptococcus or both.

The course and outcome of purulent pleuritis are most assuredly dependent to a very large extent upon the antecedent infection and for this reason it is important to remember, that the surgical treatment of this condition is often a secondary matter.

The term empyema certainly has played a large and often dangerous part in the selection of various types of surgical intervention in the treatment of purulent pleuritis. It has been a most misleading term, because of the fact that many cases of purulent pleuritis, encountered during the past year, have not answered the description generally understood to mean empyema.

A review of the literature of the past brings forth two principal types of treatment:

1. Open methods, either by rib resection or intercostal thoracotomy with permanent drainage.
2. Closed method by repeated aspirations.

The open method with resection of one or more ribs was and is recommended by some. This method was modified by various men, for the improvement of drainage and production of negative pressure, such as the syphon pump, Brewer tubes, rubber suction bulbs, rubber flaps to cover outlet of tubes, allowing egress but no ingress of air into the pleural cavity.

A method used in Europe and to some extent in this country, was the introduction of a catheter as a means of aspirating the pleural cavity. Irrigations were considered dangerous and seldom used until lately.

The closed method with frequent paracentesis and aspirations was recommended by some and Murphy advised the injection of 2 per cent formalin in glycerine after aspiration as a means of sterilizing the pleural cavity and aiding absorption of the exudate.

The subject of treatment as discussed in textbooks as a rule, consisted of a description of one or more types of operations, these usually being emphasized, while little or no reference was made to the type of infection or the stage of the disease, with the exception of the last stages when decortication, thoracoplasty, or bismuth paste injection were recommended. This condition persisted up to the present year and even now we find reports in various journals where the treatment recommended consists of rib resections, aspirations, aspirations with rib resections later, and catheter drainage by means of one or more catheters, some advising irrigations, and others not. This most striking difference in methods, apparently with often almost equally good results, must most assuredly be dependent on some common factor, the result of selected cases or else a coincidence.

The object of this paper, therefore, is an attempt to analyze the reason for this apparent difference in methods with equally good results and apparent similarity of methods with strikingly different results, with a view of establishing a clear conception of when one method should be used and when another.

The following statistics are compiled in three-month periods, therefore, covering the

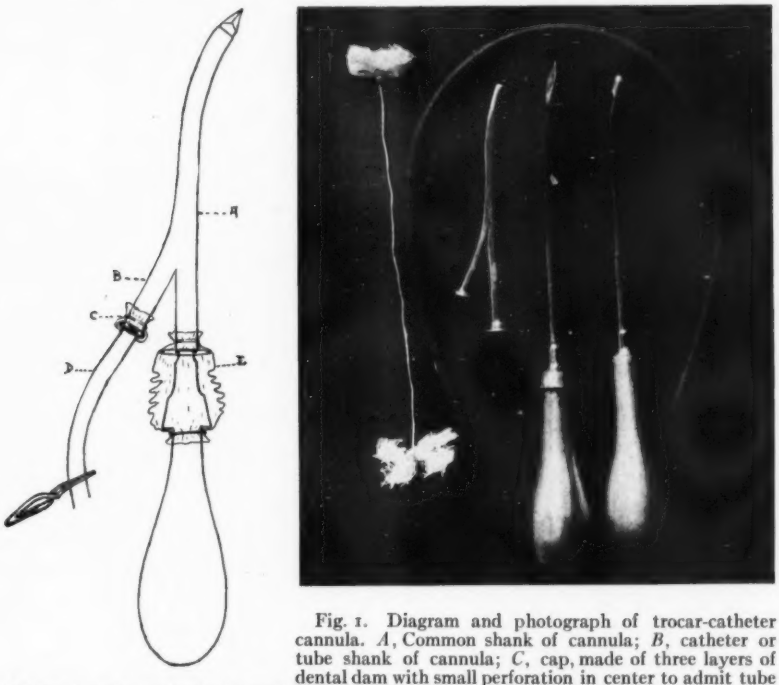

Fig. 1. Diagram and photograph of trocar-catheter cannula. *A*, Common shank of cannula; *B*, catheter or tube shank of cannula; *C*, cap, made of three layers of dental dam with small perforation in center to admit tube tightly; *D*, tube—standard Carrel-Dakin tubing—clamped shut; *E*, thin rubber tube or condom tied over handle of trocar and outlet of cannula making an airtight connection.

various seasons and also three distinct main types of primary infection as mentioned above. They include 225 cases. Of this number 147 came under my care during their entire course, while 78 who had been admitted to the empyema ward during the months of January and February include 30 who died before March 1 and 48 on whom I did the postoperative dressings.

JANUARY AND FEBRUARY SERIES

This series in which I took no part in the treatment except the later after-treatment includes the cases occurring during the severe winter months, when patients were kept indoors, when the hæmolytic streptococcus infection was most virulent and measles was a frequent primary infection. Because an entirely different method of treatment was employed in this series from that which was used in the later cases I am including this series for comparison:

		Per cent
During the month of January:		
Number of cases admitted	63	
Deaths	30	47.6
Method of treatment:		
Rib resection	63	
Deaths	30	47.6
During the month of February:		
Number of cases admitted	15	
Deaths	1	
Method of treatment:		
Rib resections	13	
Deaths	1	6.9
Aspirations	2	
Deaths	0	

MARCH, APRIL AND MAY

The majority of cases admitted during March and April were suffering from a hæmolytic streptococcus infection and many were still suffering from an active pneumonia. They were also handicapped in so far as climatic conditions were unfavorable. Until the latter part of March all cases were kept indoors.

Fig. 2. Diagrammatic sketch showing course of tube through chest wall. Tissue flap at *A* acts as valve flap.

		Per cent
During the month of March:		
Number of cases admitted	14	
Deaths	5	35.7
Method of treatment:		
Rib resection	14	
Deaths	5	35.7
During the month of April:		
Number of cases admitted	16	
Deaths	1	
Method of treatment:		
Rib resection	4	
Deaths	1	.25
Aspirations	1	
Deaths	0	
Trocar thoracotomy:		
Catheter aspiration and irrigation	11	
Deaths	0	
During the month of May:		
Number of cases admitted	12	
Deaths	1	
Method of treatment:		
Rib resection	0	
Aspirations	4	
Deaths	1	25
Trocar thoracotomy:		Per cent
Catheter aspiration and irrigation	8	
Deaths	0	

JUNE, JULY AND AUGUST

The cases admitted during these months with a very few exceptions had primary lobar or bronchopneumonia. They were usually men who had been in camp for several months, and, consequently, hardened and in better condition than those in the preceding series. The weather conditions were also favorable.

		Per cent
During the months of June, July and August:		
Number of cases admitted	12	
Deaths	0	
Method of treatment:		
Trocar thoracotomy with catheter aspiration and irrigation	15	
Deaths	0	

SEPTEMBER, OCTOBER AND NOVEMBER

(Influenza Period)

This period was undoubtedly the most severe. The majority of the patients had passed through an attack of the influenza which was followed usually by bronchopneumonia, sometimes lobar pneumonia and often both. They entered the empyema ward, as a rule, still suffering from an active pneumonia, not infrequently bilateral. Of this series 9 per cent had a bilateral empyema.

		Per cent
During the months of September, October and November:		
Number of cases admitted	88	
Deaths	20	22.7
Method of treatment:		
Aspirations	27	
Deaths	13	48.09
Thoracotomy	61	
Deaths	7	11.47
Bacteriology of this series:		
Number of cases	88	
Deaths	20	22.7
Culture of pleural fluid in above 20 cases:		
Hæmolytic streptococcus was found in	18	
Hæmolytic streptococcus and pneumococcus in	1	
Pneumococcus type in	1	
Pleural fluid examinations in the entire series:		
Number of cases cultured	88	
Streptococcus hæmolyticus	44	50
Streptococcus non-hæmolyticus		3.40
Streptococcus and pneumococcus		13.68
Streptococcus and influenza bacillus		2.20

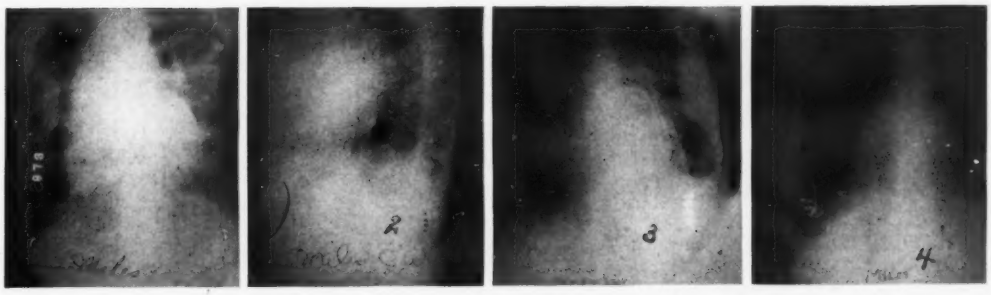

Fig. 3. Case 51. Midpleural empyema (left). *1*, Patient lying on breast. X-ray of encysted empyema between inner surface of left lung and mediastinum. Note resemblance to shadow of purulent pericarditis or effusion. The straight edge on left side differentiates it from a precardial affair which would be bowl-shaped. *2*, Lateral view of same case showing that pus extended posteriorly, thus enveloping root of lung. This also helps to differentiate it from a precardial affair. *3*, Patient lying on back; shows tube *in situ*, it having been inserted anteriorly. *4*, Patient lying on breast. View showing patient after he had entirely recovered. Compare this case with Fig. 4.

		Per cent
Pneumococcus	27	29.51
Type I		1.13
Type II		3.40
Type IIa		4.54
Type III		7.95
Type IV		3.40
Undetermined		9.09
Pneumococcus and influenza bacillus		1.13

Resections total, 94, 37 deaths, or 39.7 per cent; aspirations total, 34, 14 deaths, or 41.1 per cent; trocar-catheter, total 9, 7 deaths, or 8.05 per cent.

An analysis of the above four series of cases brings out the following very interesting results, which, in some respects, are apparently very contradictory both here as well as to the results obtained at other camps:

During the months of January and February, 1918, at Camp Pike, practically all cases of purulent pleuritis were treated by primary rib resection. From what I saw of the latter part of this series during the month of March, I would say that it was the rule to do a rib resection as soon as fluid was found in the pleural cavity, providing it contained organisms, irrespective of whether it was serofibrinous, seropurulent or purulent. It was classed as empyema and treated according to the textbook teaching for this condition.

During the month of January, 63 cases were admitted and 30 died, a mortality of 47.6 per cent. In February, 15 cases were admitted and one died. Here in two successive months we have two series of cases both treated by the same method. One with a mortality of 47.6 per cent and the other with a mortality of 6.9 per cent. No irrigations were used.

Had the results of February been used as a criterion, resection would probably have been recommended. Four times as many cases were admitted in January as February. In March the mortality rose again to 35.7 per cent and dropped to 6.2 per cent in April; however, in April the treatment was changed to that used at the present time; namely, trocar-catheter with Dakin's irrigations. It is fair to assume that during January the virulence of the infection was at its height, and the majority had an active hæmolytic streptococcus pneumonia, when they entered the empyema ward. The drop in the number of cases in February would lead one to suppose that the epidemic was on the decline. The majority of these cases were patients who had recovered from their pneumonia or had pneumococcus infections while the earlier ones were mostly hæmolytic streptococcus infections.

The same effect can be seen in the results obtained by other methods. During the month of April, May, June, July and August when no severe epidemic or pneumonia existed in camp, the mortality by the trocar-cannula method was nil in a series of 34 cases. It would have undoubtedly been higher had this same number of cases been treated in January and February. This was

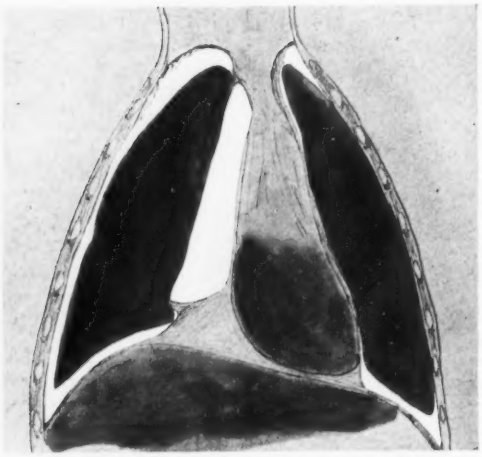

Fig. 4. Sketch from photograph of autopsy showing encysted empyema on the inner surface of right lung, also empyema of right and left pleural cavities. (Pus collections shown in white.) Purulent bronchitis and bronchopneumonia of both lungs.

shown in the recent influenza epidemic of October and November, when out of 61 cases treated by the trocar-cannula method the mortality was 11.47 per cent, a marked increase in death rate over the summer months and yet much better than 47.6 per cent by the resection method used in January, February, and March. This point is again emphasized by the mortality of 48 per cent in 27 cases who were aspirated during the influenza period.

A word might be said here regarding the high mortality of the cases aspirated. Some have recommended the aspiration method. Results have been published which were excellent so far as low mortality is concerned. Our experience at this camp has been that although aspirations in the early stages should be done in the great majority of cases, it will be necessary to do a thoracotomy later and to irrigate the empyema cavity.

The mortality of 41.1 per cent in cases who had merely been aspirated during the recent epidemic means that those were cases who were still suffering from an active pneumonia. They were referred to the empyema service because fluid containing organisms had been found. At autopsy these cases showed not only an active pneumonia, but very frequently serofibrinous or seropurulent fluid was found at aspiration or autopsy, in quantities insufficient to have caused death.

A small percentage of those cases aspirated repeatedly, preparatory to insertion of a tube by means of a trocar and cannula, recovered before it became necessary to use a tube.

In view of the above facts, we may say therefore, that the status of the aspiration method is, that it is to be used as a preliminary method, in those cases with serofibrinous or seropurulent fluid, when pneumonia often is still present and adhesions have not formed to wall off the empyema cavity and attach the lung about the abscess cavity to the chest wall. After these adhesions have formed, by which time the fluid is purulent, irrigations can be used and pneumothorax if produced, is limited to the abscess cavity. Collapse of large portions of the lung is thereby avoided, an important factor, especially at the time when there is little healthy functionating lung tissue present. Also by this means, a small percentage of cases will recover without further surgical intervention.

The use of 2 per cent formalin in glycerine after aspirations was tried in three cases before we began using the trocar-cannula method. In my opinion the method offers little improvement over the simple aspiration method. Thoracotomy must be resorted to later and convalescence of the patient is unnecessarily prolonged, with the exception of that small percentage of cases, who get well without resorting to anything after simple aspirations have been done.

Primary rib resection, especially in those virulent hæmolytic streptococcus and pneumococcus infections as seen in the recent epidemic will, I am sure, be condemned when its results of last winter are compared with those obtained by the combined aspiration and trocar-catheter method as used at this camp.

Looking at the statistics from April to December, we find that 95 cases have been treated by this method with 7 deaths, or a mortality of 7.05 per cent. Results which would compare favorably with these I feel

Fig. 5. Empyema patient being irrigated.

Fig. 6. Convalescent empyema patient. Small scar one inch below and three inches posteriorly to left nipple was the site of thoracotomy. Note expansion of patient's chest.

would be the same series of cases treated by the method as outlined by the Empyema Commission at Camp Lee last spring.

They recommend aspiration followed by rib resection and irrigation with Dakin's solution. They recommend resection on the ground that the good surgical principle of free drainage should be used once the empyema cavity has been walled off.

I have had no experience with this method; inasmuch as those cases with rib resections last spring who were irrigated with Dakin's solution had not had preliminary aspirations. The results with the trocar-catheter method, however, have been too good to wish trying anything else.

The average length of time elapsing between the thoracotomy and the closure of the chest was 40 days. From present indications this time will be considerably shortened in the present series. The rapidity of closure is greatly dependent upon the thoroughness in which irrigations and aspirations are done, and with over 50 cases to be irrigated from 4 to 8 times in 24 hours it is easy to see that organization and sufficient help are important factors in the management of these cases.

The treatment is carried out in the following manner:

After a diagnosis of pleural effusion has been made, the pleural cavity is aspirated with a syringe and the specimen sent to the laboratory. Those cases who are still suffering from pneumonia and are in a critical condition, are not moved from the medical ward until one or two aspirations have been made. In the meantime a report has been made from the laboratory, giving the type of organism in the fluid. Those cases with hæmolytic streptococcus are sent to the streptococcus empyema ward and those with pneumococcus are sent to the pneumococcus ward. All cases in these wards are kept on the porches.

The frequency of aspirations is dependent on the rapidity with which fluid re-accumulates. In the hæmolytic streptococcus cases, while the fluid is serofibrinous it accumulates very rapidly. Often two and occasionally four aspirations are necessary in 24 hours. This is especially true if there is a pneumonia or purulent bronchitis present on the opposite side when every bit of available lung tissue is necessary. In the course of a week or ten days the fluid accumulates slowly, at which time aspirations are done every third or fourth day. In the hæmolytic streptococcus cases, the fluid now becomes thick and creamy in consistency and is usually of a slightly greenish tinge. Aspiration by means of a needle even of large caliber becomes difficult and it is then time to do a trocar thoracotomy. In cases of bilateral empyema, aspirations are continued even longer.

In the meantime stereoscopic X-ray pictures have been taken one or more times and a definite idea obtained as to the extent and character of the cavity. The progress of the

patient is often stormy during this period and as mentioned before, pneumonia is usually present during this time. There is usually a marked improvement following each aspiration.

TROCAR THORACOTOMY

The principle upon which I have based the trocar thoracotomy technique is that of preventing ingress, but allowing outlet of air from the pleural cavity.

The matter of allowing air into the pleural cavity is not a serious one after the empyema cavity has become walled off, and yet I feel that in those instances, especially with rib resections where there is a continuous rush of air in and out of the cavity, patients do not do as well as they should.

Any method of drainage through the chest wall is bound to leak air after a few days. This method, however, prevents leakage of air for a week and often much longer and even after that, it acts as a valve allowing the air to escape freely but allowing very little to enter.

The location and limits of the cavity having been established, a site for the thoracotomy is selected. It is unnecessary to select the most dependent portion of the cavity, as the tube passes to the bottom of it. If possible a site is selected near the anterior axillary line. This is done because the heavy muscles of the back are avoided, thereby reducing discomfort and pain from the tube and dressing. The wound is also kept in better condition.

With 5 per cent procaine and adrenalin, dermal, subcutaneous and intercostal anæsthesia is produced at the site of operation. The skin is then punctured with the point of a scalpel, sufficiently to allow a snug passage of the trocar. This puncture wound is made at least one inch below the upper border of the rib or in other words over the interspace below the one to be punctured. The trocar and cannula with a tube inserted (Fig. 1), are then passed through the puncture wound and upward over the outer surface of the rib, until it reaches the upper margin of the rib. When the upper margin of the rib is reached the tip of the trocar is pointed inward and hugging the upper margin of the rib closely, thereby avoiding the intercostal vessels, it is forced into the cavity.

The trocar is then withdrawn from the cannula sufficiently to allow the Dakin tube, which is held in the extra arm of the cannula (see Fig. 2), to be pushed into the cavity. The rubber fittings about the outer ends of the cannula prevent any air from entering the pleural cavity about the trocar or tube. The outer end of the tube has been clamped before, and when it has been inserted deep enough into the cavity, the cannula is withdrawn over it. The tube is then clamped near its entrance into the skin thereby allowing the clamp to be removed from the outer end, when the cannula can be slipped off from the tube entirely.

A 50-cubic centimeter Leur syringe is then attached to the tube and the cavity aspirated. The cavity is then irrigated with normal saline solution. If the patient does not cough, Dakin's solution is used. Only a very few cubic centimeters are injected at first. This is done because of the fact that, occasionally, there is a pulmonary fistula connecting with the cavity, through a ruptured subpleural abscess. In this case, the Dakin solution enters the lung and a severe attack of coughing is caused. If this be the case, the solution is discontinued and salt solution or no irrigations are used. This condition, however, is not very common and irrigations with Dakin's solution are continued until the fluid returns clear. When the syringe is detached the tube is always clamped, thereby allowing no air to enter the pleural cavity.

The tube is attached to the skin by means of two linen threads fastened to the skin with adhesive. The tube is then passed through a 10-inch square cotton pad. This is covered with another and these are held in place by adhesive.

Patients are irrigated with Dakin's solution from 6 to 8 times in 24 hours. Irrigations may be done by removing only the outer pad. Each irrigation is continued until the solution returns perfectly clear. A small quantity, 5 to 30 cubic centimeters, is allowed to remain in the cavity.

The use of Dakin's solution to irrigate these cavities is undoubtedly of great value. In those cases, however, with pulmonary fistula, Dakin's solution can not be used. Even a few cubic centimeters passed into such cases is sufficient to set up a severe attack of coughing and the patient will say usually that he feels as if he were being strangled. In these cases the cavity is irrigated with salt solution and the patient is made to lie on the side involved.

We have used optochin (ethylhydrocuprein) in 1 per cent solution in pneumococcus cases, especially in those who have pulmonary fistula. Results have been better than where salt solution was used but not as good as in those cases where Dakin's solution was used.

A few days after thoracotomy has been done, patients are given blow bottles. The amount of this exercise is controlled entirely by the patient's condition. At the end of two weeks, at which time the patient is usually in good condition, he is blowing the bottles from eight to fifteen times daily. That is, he has emptied from eight to fifteen gallons of water during the day. From X-ray controls we have found that these exercises undoubtedly aid in the expansion of the lungs. After a few days of irrigation the fluid from the cavity becomes clear, somewhat gelatinous, and then mucilaginous in character.

A specimen is then taken in the morning and sent to the laboratory for a smear count. When the fluid shows no organisms by smear count, a culture count is made. If this is negative, on two successive days, after no Dakin's solution has been left in the cavity for eight hours, the thoracotomy wound is closed.

The patient is taken to the operating room and thoroughly irrigated with Dakin's solution. Under local anæsthesia the fistula is excised very easily. This is done to decrease any danger of contamination of the cavity from infection which might result from the fistula.

Blowing the bottles is discontinued for five days; the two silkworm sutures are then removed, and in a few days the patient begins his blowing exercises again.

NUTRITION

An important factor is the nutrition of these patients. Every effort is made to keep the nutrition up to the very highest point. They are fed frequently. Besides their regular meals, they are given egg-nogs, milk, ice cream or cocoa between meals.

Another important factor is the keeping up of the morale and consequently a good appetite of these patients. Constant attention to those things which make them happy and comfortable is very necessary. First of all in cold weather it is important to be constantly on the watch to see that they are well blanketed. Games and music by means of a Victrola were supplied occasionally. Above all a discussion of cases, either by nurses and officers in the presence of patients was never tolerated. Another point which is so often overlooked: Whenever a patient entered a ward *in extremis* and the prognosis was grave, he was not put in a small room inside because he was expected to die, but was put on the end porch with plenty of fresh air, but isolated from the other patients. It is remarkable what effect one death in a ward has on the morale of the patients. When patients were convalescing they spent part of their time folding dressings and reclaiming washed gauze. Another point which adds greatly to their comfort and for which they are probably most thankful is regular shaving and a haircut. Convalescents were used for this purpose. In other words the ward was made a happy community, every one helped his neighbor and the result was happy patients with a good appetite.

The only control of their metabolism was their general condition and weight. They were weighed regularly every week. Gains as high as eight pounds a week have been recorded.

After patients were strong enough to take exercise, they were put in classes and given breathing exercises twice daily. They have all left the hospital in the best of health and spirit, some weighing more than ever before and pictures of health.

Of the series treated during the early summer months I have found by correspondence that they are feeling very well and there

have been no recurrences. Of those cases on whom resections were done, five have recurred to my knowledge.

SUMMARY AND CONCLUSIONS

Summing up the subject of empyema as I have seen it at Camp Pike Base Hospital, I would say that it, together with pneumonia, is the condition demanding the most attention and care. The cases have come usually in waves and at times when the hospital was severely taxed both for help and space. These waves have followed epidemics such as measles and influenza which had undermined the health of the men.

Under conditions such as these, the factor which was of vital importance was organization, in other words team work. With the ever changing personnel this was doubly necessary, with vigilance both day and night.

Prophylaxis. Nothing probably has been so thoroughly proven relative to this subject, as the importance of crossed infections in pneumonia, empyema, both during their primary infection as well as later.

Therefore, all hæmolytic streptococcus infections as well as carriers should be isolated. If not pneumococcus cases may develop hæmolytic streptococcus pneumonias. The same is true of pneumococcus cases of different types. They should be separated so that a type II pneumococcus does not contract a type IV pneumococcus pneumonia, *et cetera.* If this is carried out in the contagious wards, the percentage of hæmolytic streptococcus pneumonias and purulent pleuritis will certainly be extremely small.

TREATMENT

The treatment of purulent pleuritis resolves itself into two phases, the *early phase* when pneumonia is still present, and when the presence of infected fluid in the pleural cavity is only a menace, when in quantities large enough to embarass respirations or heart action, by displacing the thoracic viscera. A small quantity of fluid may be of benefit to the inflamed pleura by separating it, and also splinting the lung. During this stage aspirations should be done. They should be done with the greatest care to avoid injuring the lung and producing a pneumothorax.

In my estimation aspiration increases to some extent the formation of pockets, but this even is of less danger than an early pneumothorax, whereby the lung is often completely collapsed. If pockets are produced, they can be easily taken care of by the trocar-cannula method.

The late stage. When the fluid has become distinctly purulent and as mentioned above, the pus has become walled off, it is time to do the trocar thoracotomy. This should be done according to the technique as described above.

Blowing against positive pressure with the blow bottles is of distinct value in aiding the expansion of the lungs.

Patients must be kept out of doors and warmly clothed.

Nutrition is highly important. Hæmolytic streptococcic cases become emaciated very rapidly. Keeping them in a happy frame of mind improves their appetites and hastens their convalescence.

Dental hygiene. Care of the teeth and mouth was insisted upon.

Medication. Digitalis was not used. In cases of failing heart action ice bags were placed over the precordium and camphorated oil given subcutaneously.

Glucose in a 25 per cent solution was given intravenously in those cases entering the wards with a pneumonia and showing signs of dehydration and acidosis. This solution as well as normal saline was prepared in 500-cubic centimeters Erlenmeyer flasks. This method is very simple, rapid and a distinct improvement over many others. Two hundred and fifty cubic centimeters were given in one hour and this repeated in 12 hours until the patient showed considerable improvement and was taking sufficiently of liquids by mouth.

Liquids. Patients were required to take liquids in the form of water, milk, and lemonade very freely, especially during the early stages.

Tonics. Iron, quinine and strychnine were given in all cases to improve their appetite.

Exercises. After the wounds were closed and the patients were well along to convalescence, they were put in classes and given breathing and setting up exercises twice daily, which was gradually increased. They were then also given light ward duties, such as looking after the blow bottles, shaving, *et cetera.*

CONCLUSIONS

Constant attention and the very best of care are absolutely necessary on the part of the doctor, nurses and corpsmen to get good results in the treatment of purulent pleuritis.

The trocar-cannula thoracotomy followed by the insertion of the Dakin-Carrel tube, according to the method I have described affords the following advantages:

1. The operation is very simple and can be done with the patient in bed as easily as can a paracentesis (see Fig. 5).

2. If done properly, no air enters the pleural cavity for several days.

3. Because of the flap-valve character of the opening, air passes from the pleural cavity much easier than it enters; consequently there is a continuous automatic production of negative pressure in the cavity, at least relative if not absolute as compared with the normal.

4. Dressings are never soiled and therefore they give the patient very little discomfort.

5. In cases with multiple pockets and pus in inaccessible places it is very advantageous (see Figs. 3 and 4).

6. There is no resultant deformity of the chest (see Fig. 6).

7. Convalescence is rapid and no recurrence has occurred.

Dakin's solution is of distinct value both for its antigermicidal properties as well as solvent action in these cases. It not only dissolves the exudate but aids the expansion of the lung by quickly removing the heavy plaques of fibrin from the pleural surface and preventing a fibrous thickening of the pleura.

Note.— The tube may be attached to a combined suction and irrigating apparatus.

Since this report was submitted twelve more cases have been treated by the trocar-cannula method with excellent results.

OBSERVATIONS ON EMPYEMA

By J. GARLAND SHERRILL, A.M., M.D., F.A.C.S., Louisville, Kentucky
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THERE is no subject of more importance for the consideration of the profession at this time than that of empyema. The virulence and extent of the epidemic of the past winter, with its high ratio of incidence and excessive mortality at the height of the epidemic, make it a problem not only for the army but for the civil population as well.

It has been the experience of most surgeons in civil practice that patients suffering from empyema usually get well, and the problem has not been to obtain recovery from the immediate illness, but to prevent the condition from becoming chronic and resulting in a persistent fistula. This to some extent has been due to the fact that in civil practice these patients come to the surgeon after they have passed through an attack of pneumonia, and attention has been called to the pleurisy by the persistence of the fever and the respiratory distress. The physical signs at this time conclusively show the presence of fluid in the thorax, and no great diagnostic acumen is needed to determine the presence of pus. In thoroughly equipped hospitals, and particularly those of the army where every laboratory facility is afforded, the diagnosis is made so promptly that the fluid in the chest may scarcely show a discoloration from the presence of the pus-producing organisms. Because of this fact there has been a tendency to open the chest or begin other surgical

measures immediately while the pneumonic process has not completely subsided. The natural result of this early intervention has been a high rate of mortality, so high in fact that it is far above that seen in civil practice prior to the present epidemic. The early intervention, however, does not entirely explain the high mortality, for in civil hospitals there has also been an increase in the death rate from this affection. In fact, some of these patients come into the hospital with a purulent peritonitis in addition to an empyema; pericarditis is a not infrequent accompaniment, and a few cases may show small multiple furuncles in the skin, endocarditis, arthritis or otitis media; and in some where this is not the case the patient is immediately overwhelmed.

It is necessary, therefore, to look further for an explanation of the severity of the infection. A particular form of organism first suggests itself as a cause, but the bacterial flora found were streptococci, pneumococci, and staphylococci, — well-known strains of pathogenic organisms. There were found in these cases, however, a preponderance of the type of streptococcus which has the power of producing hæmolysis, the streptococcus hæmolyticus, which seemed to have an unusually toxic effect. The mixed types were also found to produce particularly severe results. In the latter part of the epidemic there seemed to be a considerable diminution in the virulence of the infective organism, the streptococcus hæmolyticus at this time being no more virulent apparently than other forms. This at least was my observation, as I recall five cases occurring in the late spring in which this organism was found, without mortality.

It is not fair to compare the high death rate in the early weeks of the epidemic or at its height with that of its decline, since all epidemics end by such a decline in the virulence of the infective organism. It is fair, however, to compare two methods of treatment when applied side by side, and also when one plan has a persistently high mortality and another employed immediately and almost coincidentally shows a very low death rate or none at all.

When I was first placed in charge of the empyema ward at Camp Sherman the mortality was depressingly high, notwithstanding the fact that one of the approved methods of treatment was being employed. This was so noticeable that I asked myself the question whether it was as good as the plan so long in vogue in civil practice. Up to this time aspiration repeated at intervals had been tried and abandoned, thoracotomy with the employment of Carrel-Dakin fluid being the method then used. It is but fair to say that there was a slight but not material difference in the technique from that which I had observed at the Rockefeller Institute, in that two tubes large enough to admit in the lumen of each a Carrel tube, were inserted through a thoracotomy wound, and through the latter the antiseptic solution was instilled. In every other detail the treatment was as directed at the Rockefeller Institute. These patients did fairly well for several days, the amount of the discharge was lessened, and no appreciable odor was found about the ward. The bacterial count apparently was diminishing from day to day, but it seldom remained low long enough for one to feel safe in attempting to close the chest wound. I saw several wounds closed in from nine to twelve days at the Rockefeller Institute with apparent success. The fluid was checked properly and carefully by the laboratory force so that its strength and alkalinity were known to be all that could be desired. Notwithstanding this fact a number of these patients who apparently had been doing fairly well began to show gradual prostration, slight irritation about the wound which appeared as a brawny, glazed, toughened skin, and a thickened, dry pleura. The secretion from the chest was greatly diminished and in a short time ceased entirely. It was found that only by the immediate discontinuance of the treatment could the irritation be checked. If the treatment was continued these patients became weaker, suffered from nausea, pain in the chest, vomiting, with a temperature normal or slightly subnormal, finally dying in exhaustion. In similar cases, where the treatment was immediately discontinued on the first sign of irritation, recovery followed. These results induced the conclusion that the use of a

per cent solution of formalin in glycerine, a method which had been employed for some years in old cases of empyema, would be more efficacious than the Carrel-Dakin fluid, and it was at once substituted.

The results following the change of treatment were very striking to those who had not been familiar with this method. It had been employed by us so long and with such satisfactory results that we pictured just what it would do. The mortality promptly fell from over 50 per cent to 5 per cent, a remarkable difference. With this result it was no difficult matter for us to have the old method of John B. Murphy tried, consisting in the removal by thoracentesis of the pus from the pleural cavity, and through the same syringe to insert one ounce of glycerine and formalin. This is readily accomplished without pain or much distress, and should be repeated every third or fourth day until the fluid is perfectly clear and sterile.

To one not familiar with the change resulting from this simple treatment the result is spectacular. After the first treatment there is an immediate change in the color of the fluid and a very small amount of pus collects at the bottom of a test tube in which collected; on the second treatment the fluid becomes clear but rather deeply pink; and usually after the third treatment the fluid is a clear yellow sterile fluid. The quantity shows a gradual reduction, and although there is immediately after the injection an increase of fluid in the chest, it is rapidly diminished by absorption.

The advantages of this method are very apparent even to the most casual observer. There is no necessity of an open wound, and with care the slight danger from tapping need not be considered; the recovery is more rapid than by any other method, and it does not leave the chest impaired because the affection does not become chronic and pleural adhesions do not cripple the lung.

There are one or two other points worthy of mention: First, the solution must be made the day before it is used, because it takes eighteen hours for solution of the formalin in the glycerin, and if the injection is made into the pleura when there is a connection between the cavity and a bronchus a very distressing cough will be excited. The patients so treated begin at once to show improvement, their appetite becomes voracious and they take on flesh. If the bronchus communicates with the pus cavity, simple tapping may be employed or an open operation done, since cough and dyspnœa are excited by fluid entering the bronchus.

A most simple method of applying an antiseptic to the chest cavity has been devised by Captain A. E. Mozingo who had charge of the empyema ward at the Walter Reed General Hospital during and prior to my service there. This consists of a stab wound made in the eighth interspace just large enough to admit a small drainage tube. After the tube is inserted the chest is freed of its fluid by means of a suction syringe and negative pressure. The tube is fastened to the chest wall by a safety pin and kept closed by a serrefine. Captain Mozingo developed this method to employ Carrel-Dakin fluid, which was instilled every two hours, left for fifteen minutes, and then withdrawn, the pleural cavity being kept under negative pressure. I consider this to be one of the best methods offered for the application of any antiseptic, but suggested to Captain Mozingo that a large trocar carrying a small catheter through its lumen would make the installation of the tube even simpler, and do away with repeated aspirations and the pain, etc., incident thereto.

Some patients remain in the hospital as long as one hundred and twenty days under the Carrel-Dakin method which allows the disease to become chronic, a condition that can be avoided by the formalin method. Particularly is this true where the method of Murphy is successful, since these cases are relieved so promptly that there is but little opportunity for pocketing of pus by formation of adhesions. Graduated breathing exercises will materially aid in the expansion of the lung. This is a valuable measure also where the open operative procedure has been employed.

I wish particularly to emphasize the necessity to use every effort to avoid chronicity and sinus formation. After satisfactory drainage is established the lung should expand promptly, and when it fails to do so after

suppuration is checked by formalin and the fluid becomes clear, then prompt and radical measures are indicated. Only by the prompt adoption of such plan can these patients be brought to a recovery within a reasonable time. Some of them will recover with a chest greatly crippled, and these are the cases in which treatment has been delayed. Such patients as this latter class rarely make soldiers fit for full duty. Many of those treated early and properly may be promptly brought to a duty status, that is within three to six weeks; cases running as long as two to four months are always more or less crippled in their respiratory function.

It would be unwise to leave this subject without placing emphasis upon the fact that some cases are fatal from the inception of the disease. All serous membranes may be involved and the patient die of an overwhelming toxæmia for which neither medical nor surgical skill offers at present any satisfactory remedy. It is doubtful if, in the presence of pericarditis, peritonitis and empyema combined, anything more in an operative way is justifiable than aspiration followed by the injection of formalin, and in some of these cases where the toxæmia is terrific it may be well to defer this measure until the patient adjusts himself somewhat to the combat. Certain it is that distressing dyspnœa or cardiac distress is sufficient reason for aspiration, which must be done slowly and with care in these serious cases. It should not be repeated with such frequency as to tax the patient's strength or to deplete him because of the loss of large amounts of fluid. No matter how carefully done there is always the possibility of contamination of a simple pleural effusion.

The open operation has one advantage in suppurative pleurisy, and that is in the ready removal of the large masses of fibrinous lymph so often seen. This is particularly the case where rib resection is done. The Carrel-Dakin fluid also will probably remove this lymph because of its solvent action upon animal structures. It has seemed to us possible that this solvent action after the lymph was removed continued in a destructive way upon the pleura itself. It is an established fact that it acts in this way on the peritoneal structures. We were not permitted by autopsy finally to determine this point, but hope to do so experimentally when the occasion permits. In some chronic cases where the Carrel-Dakin method had failed and subsequently formalin had been ineffectual, it was evident that pus pockets and a rigid lung existed, and rib resection was necessary. This step should be undertaken as soon as it is evident that healing will not occur without it.

My observation of over one hundred cases in army hospitals leads me to recommend the following as the most satisfactory plan of treatment yet offered:

1. Diagnostic tap as soon as the presence of fluid is suspected. This should not be repeated with unnecessary frequency, owing to the likelihood of the development of empyema. If the fluid is at all cloudy, an injection of one ounce of a 2 per cent formalin solution is advisable at this time, a culture of the fluid being taken before injection.

2. If there is evidence of pus in the chest cavity, aspiration with the injection of one ounce of a 2 per cent formalin and glycerine should be made. This solution should stand for 24 hours before use, because it takes sixteen hours for a complete solution. This injection should be repeated every third day, the pleural fluid having been removed prior to the injection. Care should be observed that the aspirator needle is in the pleural sac, otherwise considerable pain will result from injection into the soft tissues of the chest wall. Within a week this method will usually clear up the purulent condition and with the assistance of breathing exercises will promptly restore the patient to a duty status. The great advantage of this method, which was first proposed by John B. Murphy, lies in the fact that the condition does not become chronic and therefore the lung does not remain collapsed but distends to fill the chest cavity as the clear serum, remaining after treatment, is absorbed.

3. Failure to clear up the pus by this method may be followed by open operation, either thoracotomy or costatectomy, which can usually be accomplished under local anæsthesia. However, I have found that the ad-

ministration of chloroform in no way prejudices the chances of recovery. Open operation should not be done until the pneumonic process has subsided. The objection to thoracotomy lies in the fact that close proximity of the ribs impairs drainage and makes likely rib necrosis from pressure of the tube.

4. Cases which come to the service and are already chronic with pleural adhesions and pocketing of pus cavities, will demand the removal of portions of one or two ribs and the separation of the pleura from the chest wall by the hand of the operator. The insertion of some form of drainage, which will provide for a negative intrathoracic pressure, should be employed. I have found the combination consisting of a stiff rubber tube, one-half inch in diameter, connecting with a collapsible rubber tube, just large enough to fit over it snugly, draining into a bottle, to be most satisfactory. This allows the escape from the chest of pus and air but prevents any air entering through the tube, making an automatic pump which permits the gradual distention of the lung and obliteration of the suppurating cavity.

5. The use of the Carrel-Dakin fluid will remove the large amounts of lymph which are so frequently found in these cases. It will diminish the odor, lessen the discharge, and oftentimes entirely sterilize the cavity. This will permit closure of the wound, as soon as the bacterial count shows the cavity to be surgically clean. I do not think it has any advantage as an antiseptic in these cases over formalin and glycerine. A valuable method of its employment is the insertion of a small rubber tube through a stab wound which will diminish the necessity for dressing and enable one to put in the chest cavity any antiseptic solution which may be desired and to withdraw the same, at the same time establishing negative pressure within the chest. (A. E. Mozingo, Captain, M. C.)

6. In the very old cases, one of the well established very radical operations should be employed but only after the injection of formalin and glycerine into the chest pockets and plugging of the drainage tract, as this will in the great majority of cases result in a cure.

7. Beginning just as soon as the patient is able to be out of bed, graduated exercises should be employed to encourage the distention of the lungs. This I consider is one of the most valuable portions of the treatment.

NEGATIVE PRESSURE VERSUS FREE OPEN DRAINAGE IN THORACIC EMPYEMA

By J. CHRISTOPHER O'DAY, M.D., F.A.C.S., Honolulu, Hawaii
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NEGATIVE pressure drainage has for its object certain phases that do not belong to the ordinary methods of drainage and which by some of its advocates are believed to be of considerable advantage in attaining ultimate results. These advantages may thus be enumerated: It reestablishes and maintains the normal relation between the lung and the affected cavity during the time drainage is necessary and when no longer necessary to have left the lung capable of filling the space it filled prior to the onset of the infection; it prevents pneumothorax; it prevents the likelihood of introducing secondary infections.

When should thoracic empyema be drained?

What are all the factors to be considered?

How should it be drained?

If we can become impressed with the truth that each case of thoracic empyema has peculiarities of its own, it will bring us to realize that the greatest success can only obtain with a plan that may be adjusted either to establishing or delaying drainage according to the exigencies presenting.

With an unresolved pneumonia of the op-

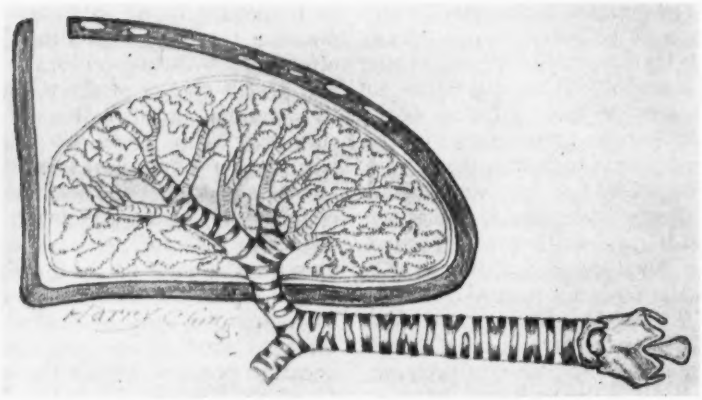

Fig. 1. Semidiagrammatic illustration of the bronchi of the lung, etc., representing the greater number of square inches of surface.

posite lung, drainage, especially a drainage that might admit air, might be hazardous. This class of cases argues strongly in favor of negative pressure drainage; yet, the inevitable mishaps, likely in opening the chest, expose the patient to a risk that had better be avoided by the aspirating of such quantities as are necessary to relieve the pressure until resolution of the opposite lung has taken place.

While this delay in the establishment of adequate drainage may jeopardize the integrity of the lung of the empyemic side, the risk is justified because it is selecting the lesser of two existing evils. In that class of cases where the lung of the opposite side is free from any involvment, all else being equal, nothing is to be gained by delay.

We are now squarely to face with the consideration of the kind of drainage to be employed. Should it be free open, a stab wound or negative pressure? Seriously, then, what are all the factors to be considered before deciding upon the precise way the drainage should be made?

Experiments[1] by me to ascertain the difference in the duration of a pneumothorax produced by nitrogen gas and one by atmospheric air, demonstrated that the normal lung may be kept in a state of collapse for months without losing a particle of its elasticity. This is not true of an infected or inflamed lung, for an inflammatory or infectious process, with its inevitable exudate, infiltrate, and subsequent fibrosis, if allowed its way, ties the lung from within and so thickens its cortex that re-expansion will never again meet the confines of the original respiratory excursions. Indeed, may I add that it is to this very fibrosis that pneumothorax in the obliteration of tuberculous cavities owes its success.

When drainage, for any reason, has been deferred and the mischief of the delay has been imposed, the resulting thickening of the cortex, together with whatever degree of impairment has befallen the normal elasticity of the lung itself, must, in the very nature of the pathology attained, bear a direct relation to the length of time in which the delay occurred. Upon this alone will the size of the dead space between the two pleuræ depend, and, once this dead space has been established, no scheme of negative pressure will be capable of drawing the fibrous or inelastic lung into former relations.

All streptococcic pneumonias do not result in thoracic empyemas. An abscess may form adjacent to a bronchus and even rupture into it, but pyogenesis within the chest comes only as an evidence that the infection has found its way to the periphery. Nor is it necessary that the entire periphery be involved before the pyogenesis begins, for a comparatively small

[1] Internat. J. Surg., 1911, Nov.

area has been observed in association with the entire cavity filled with pus. It may be well, at this juncture, to remember that the mere coming in contact with pus does not cause the pleura to thicken or become fibrous. Such a change can occur only within the area where the infection has found its way to the cortex. Often such areas are segregated by a zone of inflammatory adhesions between visceral and parietal pleuræ, localizing the subsequent abscess and often giving rise to the multiple cavities whose presence have infrequently baffled the skill of the best.

THE PNEUMATICS OF THE LUNGS

To compute the power of a given pressure of gas, steam or air the number of square inches of space and surface must be included. For example, if the bore of an engine's cylinder is twenty-four inches in diameter, that engine has a greater power than one with a cylinder whose bore is but twelve inches. The difference in the number of square inches determines the power. My alluding to this bit of scientific mechanics is to emphasize the fact that the same principle reckons with the inner and outer surface of the lung. The number of square inches represented by the manifold bronchi, bronchioli and alveoli are greatly in excess of those representing the surface. It is this, plus the normal elasticity of the lung, that makes complete collapse of the lung impossible with a plus pressure pneumothorax. It is also the excursion of exaggerated respirations lengthening the excursion of the collapsed lung to the approximation of the chest wall. This is where we have an advantage in conserving the lung's elasticity during the period it is threatened, but to gain this advantage all prejudice toward a free open drainage will have to be set aside.

We know that the pathology resulting from thoracic pyogenesis is destined to distort the lung and whether that lung is left in a state of partial collapse or kept fully inflated by the application of negative-pressure drainage, the same fate will befall it if exudate and infiltrate organizes while it is immobile, the ultimate result being that in the one case the lung cannot properly inflate while in the other it will be unable properly to compress.

Fig. 2. Case 1.

CHRONIC THORACIC EMPYEMA

In dealing with the old cases our course is usually clearly marked. We may be quite right in looking forward to finding a considerable dead space. A chronic fistula is to be no surprise. Lastly, we may find it necessary to perform an Estlander or a Schede to close the space and cure the fistula. All this is stereotyped treatment for this all too familiar result of empyema of the chest. It is also good treatment, but much of it might be prevented by a more judicious application of drainage in the beginning. But in the recent cases—the cases recognized before aught has impaired the lung's integrity—what, then, should be our method of attack? It should be one capable of preventing or minimizing the impairment of function inevitable to the process we know to be going on. This is the time when the whole crux of the situation should be squarely met and whatever is decided on as the best can only be the best if resting on a painstaking consideration of every factor involved; moreover, it makes for the best there is in surgery by forcing our mind into an attitude whereby it is unwilling to become indifferent to conserving the lung's function so soon as pus is made to appear at some point of opening. The integrity of the lung cannot be safeguarded in the presence of inadequate drainage. The lengthened excursions of exaggerated respirations are only possible with

Fig. 3. Case 2.

wide open drainage and to them alone must we look for the preventing of the exudate and infiltrate organizing *en masse*. Another important advantage of free open drainage is observed with each forced inflation. The outward excursion gathers up and sweeps the pus to the outlet.

WHAT CONSTITUTES FREE OPEN DRAINAGE

The walls of the usual abscess are, as a rule, self-collapsing after incision. We recognize the exception in the abscess of osteomyelitis. We, too, are only too well acquainted with the methods that have been put forth to aid in the closing of inelastic or uncollapsible bone cavities. We know the shortcomings of every method expounded. We know that early drainage prevents the destruction which gives rise to these cavities, "a gimlet hole," as Murphy used to put it.

Chest abscesses are not unlike the abscesses of bone cavities. They will not fall together after incision. Upon the conservation of the lung's integrity alone should the issue be met. Drainage must not be haphazard; it must be definite, and definite to a purpose, i. e., free enough that no resistance is offered the outward excursion of the lung by the escaping contents having to compress against the increased velocity of too small an opening, for just so soon as compression of surrounding air or pus begins, the advantage to be gained, by

Fig. 4. Case 3.

the bronchi of the lungs representing the greater number of square inches of surface, is immediately lost.

CASE 1. Persistent pyrexia, after drainage made by the usual rib resection, bespoke the presence of isolated cavities. An opening large enough to insert the hand enabled finding and opening three segregated areas. Following this procedure the temperature soon became normal and recovery was rapid. A small fistula persisted a few months.

CASE 2. Most unusual. Every symptom of thoracic empyema, confirmed by aspiration, present. Upon opening the chest no pus was found. Introducing a finger the visceral pleura was felt to be thickened and bulging over a fluctuant mass. An opening large enough to admit the hand was made. The lung was unwilling to collapse. No respiratory movements were noticed. There were no adhesions between visceral and parietal pleuræ notwithstanding pressure contact. The abscess was large and subcortical. The thickened cortex was made to herniate through the opening. In 24 hours it was freely incised and drained. Recovery.

CASE 3. Traumatic pneumonia result of fall through elevator shaft. Complete consolidation of left lung. Partial consolidation of the right. Before resolution was completed in the left lung, pyogenesis began in the right chest. Aspiration was resorted to, it being believed unsafe to open and drain in the presence of the unresolved condition of the opposite lung. Several ounces of pus were withdrawn. No further drainage became necessary as both sides, from the time of aspiration, progressed to complete recovery. Note the equal sides of the chest.

THE EMPYEMA PROBLEM[1]

By EMIL G. BECK, M.D., F.A.C.S., Chicago
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THERE has never been a greater opportunity to study empyema than at the present time. The country is passing through a second epidemic of pneumonia, the consequence of which is the accumulation of a very large number of cases of empyema and lung abscess. The first epidemic in the fall of 1917, lasting through the winter, was largely confined to the military camps and was mainly due to the streptococcus hæmolyticus, often associated with the pneumococcus. The second and more virulent epidemic, which began in the summer of 1918, swept the country from the Atlantic to the Pacific and did not spend its ravages on the camps alone but attacked as well the civil population. This epidemic appears to be of a different type from that of the previous year, being preceded in a large percentage of cases with what is now commonly called Spanish influenza.

Previous to these epidemics empyema was not a common complication of pneumonia; lung abscess was more frequent. We were not accustomed to watch for empyema in each case which recovered from pneumonia. It was somewhat surprising, therefore, that during the epidemic in September, October, and November, 1917, at the different camps, there appeared among the soldiers a very large number of cases of empyema after bronchopneumonia. It was evident that we had to deal with an unfamiliar type of infection. Not only were the complications more common but the mortality also was very high, ranging in various localities from 20 to 60 per cent. At Camp Pike they had from September, 1917, to September, 1918, 1285 cases of pneumonia, with a total average mortality of 26 per cent. Empyema complicated 9 per cent of these cases of pneumonia. Similar reports came from other cantonments. It was evident that this was an infection of a more virulent variety than we had treated in previous years. The anatomical conditions of these cases of empyema were likewise different. In the ordinary case of former times, as a rule, the pleural sac was found filled with pus. In the type which occurred in 1917 many cases had multiple, locked-off compartments filled with pus; sometimes abscesses were found in the spleen, liver, and abdominal cavity. It resembled more a pyæmia, with constant pleural involvement. In the present epidemic of influenza, pneumonia in a most violent form, with high and rapid mortality, asserted itself again, and thus we anticipated that empyema might also arise a little later in the recovered cases, and this proved to be the fact. I am informed that at the Great Lakes Base Hospital 250 cases of empyema following the last epidemic have already developed from recovered cases of pneumonia.

We must expect the same complications to follow the cases among the civil population, and in fact they have already begun to appear.

In a report published in the *Journal of the American Medical Association*, November 16, from Camp Sherman (Ohio), of 2,001 cases of pneumonia resulting from 7,618 cases admitted for so-called influenza, 842 died, leaving 1,159 which recovered. The writer of the article stated that at the time of publication only one case of empyema had developed in these 1,159 recovered cases. Suspecting that more cases might have developed since the report, I inquired and received reply from Major A. Friedlander, in which he states that since writing the article there had developed about 150 cases of empyema from the 1,159 which had recovered from the pneumonia.

This indicates that the empyema may develop very slowly and may not be diagnosed until several weeks after the patient had apparently recovered.

We shall learn many new facts from the present epidemic. The reports from the different camps, in which they have had the

[1] Read before the Western Surgical Association, December, 1918; and before the Academy of Surgery, Buffalo, December, 1918.

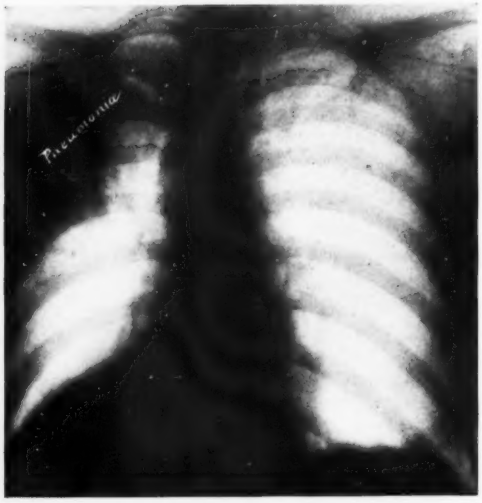


Fig. 1. Unresolved pneumonia. Upper left lobe involved.

great advantage of treating many cases of the same type by one method, are gradually finding their way into the medical literature and from them we can learn the most. It is somewhat early, however, to make comparative studies, since the reports from many camps are still missing. At the present time we must be satisfied with such analysis of the subject as our present knowledge offers, and in attempting this I shall try to answer the following questions:

1. How shall we explain this unusual virulence and high mortality of the pneumonia and empyema?
2. How shall we recognize an empyema as early as possible?
3. How shall we differentiate an empyema from a lung abscess?
4. What means other than operative may be employed to cure empyema?
5. How shall we proceed with an operation after we have made a diagnosis?
6. What operation is the most desirable, resection of a rib or drainage between the ribs? Local or general anæsthesia?
7. What method of drainage shall be introduced?
8. What shall be done to produce disinfection and closure of the pleural cavity in the shortest possible time?
9. What are the causes of non-closure of drained empyemata?
10. What shall be done with chronic suppurative cases with sinus or lung abscess or empyema, which have persisted in spite of treatment?

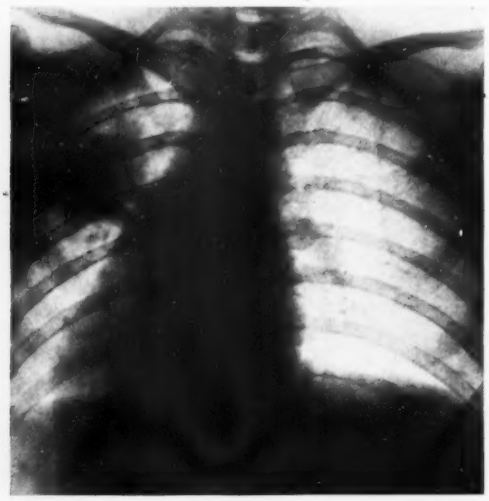


Fig. 2. Bronchopneumonia. Left side involved. Note scattered shadows representing small areas involved.

VIRULENCE AND HIGH MORTALITY

Thus far no one has ventured to make a positive statement to explain the cause of

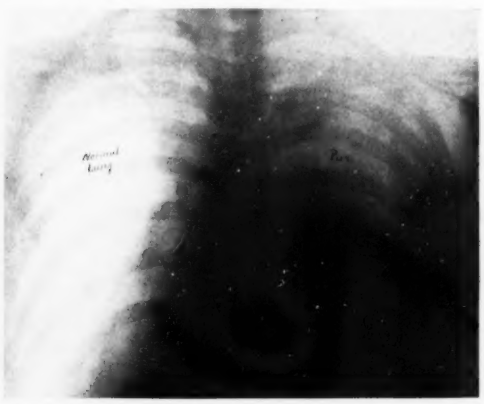


Fig. 3. Right pleura filled with fluid, except extreme apex.

the high mortality and the frequency of complications. The causative factor is not definitely known. It has been suggested that the organism causing the epidemic is an ultramicroscopic one not yet demonstrated, or the influenza bacillus which prepared the body for the pneumococcus and streptococcus invasion. The susceptibility or rather lack of immunity against this new type of infection is another theory advanced. One fact seems to stand out very plainly, namely, that robust adults are more susceptible than the very young children or people above fifty. This is just the reverse of the usual. It is also apparent that persons afflicted with asthma, chronic bronchitis, or pulmonary tuberculosis are more often spared than the perfectly healthy.[1] Alcoholism, which is considered a predisposing factor to pneumonia, cannot be claimed to be so in this epidemic. Young soldiers, rarely alcoholics, and young women are the most susceptible victims. The almost universal fatality in pregnant women also indicates that we are dealing with a new type of disease.

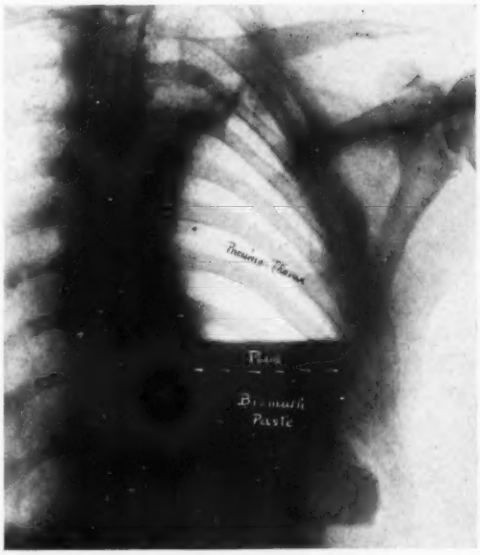


Fig. 4. Empyema. Cavity half filled with fluid, patient in sitting posture. Some paste at the bottom.

[1] A very convincing illustration of this fact appears in the *Monthly Bulletin of the Municipal Tuberculosis Sanatorium* of Chicago in December, 1918.

Of 1551 cases with pulmonary tuberculosis from six institutions, only 85, or 5.4 per cent were afflicted with influenza, only 8 cases had pneumonia as a complication, and only 1 case terminated fatally. In four of the institutions, as shown in the detailed report, there was not a single case:

	Patients	Incidence of Influenza
Municipal Tuberculosis Sanatorium	587	35
Oak Forest Infirmary	560	50
Cook County Hospital	154	0
Chicago-Winfield Hospital	55	0
Chicago Fresh-Air Hospital	100	0
Edwards Sanitarium	95	0

It is also remarkable that the cases of glandular tuberculosis were more predisposed than the pulmonary cases. Of 154, 46.2 per cent had contracted influenza, thus bringing the pulmonary type down still lower.

Comment upon this report: Is it not likely that the secondary infection in tuberculosis which is usually a streptococcus is the immunizing factor in these tuberculous individuals? Why should influenza spare the pulmonary tuberculous individual and not the glandular tuberculous? Answer: The glandular is not complicated by a secondary streptococcus.

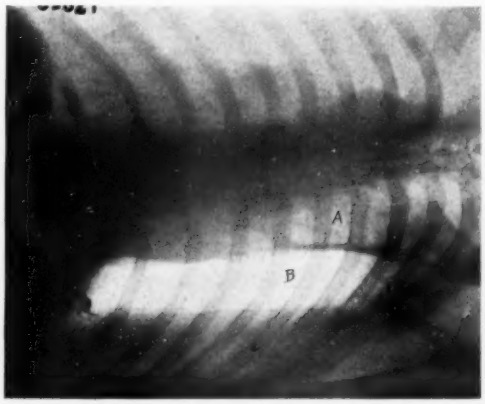


Fig. 5. Same case as in Figure 4. Patient lying on affected side. Note change in fluid gravitation: *a*, retracted lung, *b*, pneumothorax, *c*, fluid at bottom.

Fig. 6. Same patient as in Figure 4, lying on unaffected side. Fluid gravitating toward the middle line: *a*, retracted lung, *b*, fluid, *c*, pneumothorax.

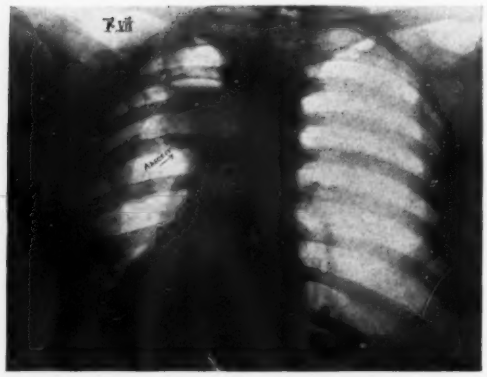


Fig. 7. Lung abscess. Somewhat unusual shape, as though it originated in the mediastinum.

The mortality rate depends largely upon the violence of the initial attack. Those who are unfortunate in receiving a severe initial blow rarely recover; cases have been reported which terminated fatally within 12 hours, from apparently perfect health to a corpse within half a day. These patients seem to die from lack of oxygen rather than from the toxic effect of the poison. The lungs are congested to such a degree that the air cannot enter the vesicles and the patient dies practically from suffocation, or rather from drowning. The heart and kidneys are not sufficiently affected to cause death. Whenever a patient has stood the first shock and bridges over the first week of illness, he has a fair chance for recovery; an index of which is found in the rise of the polymorphous leucocytes in the blood, which at the outset is very low, often as low as 4,000 and gradually rises to 10,000 or 12,000.

That the patient does not die from influenza seems certain. Only 8 per cent of the fatal cases at Camp Custer produced cultures of the Pfeiffer bacillus from the secretion of the cut lung and only 3 per cent from the blood, while 78 cases produced one or the other types of the pneumococcus and 142 cases the streptococcus. It is, therefore, evident that further investigation will be necessary to determine the real cause. Our present knowledge is too meager to establish it.

EARLY RECOGNITION OF EMPYEMA AND DIFFERENTIATION FROM LUNG ABSCESS

It is unnecessary to discuss here the usual physical signs and the part the history bears upon the differential diagnosis. We shall consider only the methods which are corroborative, namely, the stereoroentgenogram and the probatory puncture.

As soon as percussion and auscultation have convinced us that a certain portion of the chest is normal, it is our duty to take a stereoroentgenogram of the entire chest. The following conditions must be considered: (1) unresolved lobar pneumonia; (2) acute active bronchopneumonia; (3) fluid in the pleura, serous or purulent; (4) lung abscess; (5) pneumothorax; (6) acute pulmonary tuberculosis.

The correct interpretation of the stereoroentgenogram in the differentiation of the conditions just mentioned is of paramount importance and for this reason I shall present here a roentgenogram of each type, to demonstrate differential points.

Unresolved pneumonia. A dense shadow corresponding to any of the five lobes, with the rest of the lung comparatively normal, indicates an unresolved pneumonia. Figure 1 illustrates a typical case. We note that the left upper lobe on the side is quite distinctly outlined in contrast to the rest of the lung tissue. An abscess rarely produces a shadow which would correspond to the shape of a single lobe. It would produce transparent areas representing lung tissue around the abscess and possibly show a dense shadow of the abscess wall which the unresolved pneumonia does not produce.

2. *Bronchopneumonia* gives an entirely different picture. At times both lungs are involved and the picture resembles more that of an advanced tuberculosis of the lung. The entire lung, or parts of it, is studded with shadows varying in size from that of a hazelnut to that of an egg; these shadows sometimes merge into one another and leave transparent areas between them (Fig. 2).

3 *Fluid in the pleural cavity.* When the pleural cavity is entirely filled with fluid, the lung is compressed toward the hilus. If no adhesions are present it retracts upward and

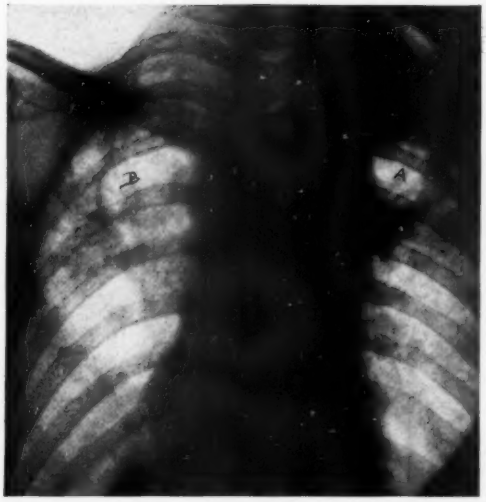


Fig. 8. Tuberculous abscess: *a*, formation of abscess wall, *b*, abscess wall not so well defined.

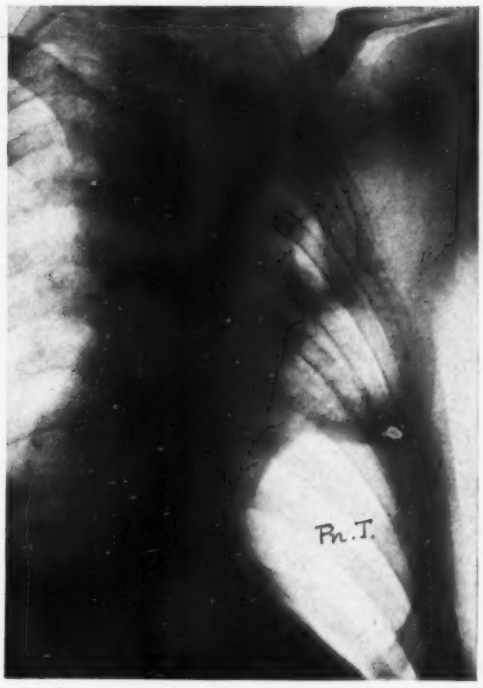


Fig. 9. Pneumothorax. Retracted lung is upward. Cavity below filled with air.

posteriorly. The roentgenogram of this condition will present a shadow resembling ground glass, nearly equal in density throughout the entire area occupied by the fluid. This, however, is true only when the patient is on his back while the roentgenogram is being taken, because the fluid gravitates and covers the entire posterior area of the pleural cavity (Fig. 3). In cases in which the quantity of fluid is not large and the roentgenogram is taken in the standing or sitting posture, we will obtain a characteristic picture: the fluid will gravitate into the lowest part of the pleura and produce a dense shadow up to its upper margin—above that there will be a distinct pneumothorax (Fig. 4). Another roentgenogram taken in the lateral position, namely with the patient lying on the affected side, will produce a shadow corresponding to the level of the fluid along the outer part of the chest, and a pneumothorax between the margin of the retracted lung and the level of the gravitating fluid. This is clearly illustrated in Figure 5. If the same patient is turned on the unaffected side the fluid will gravitate toward the middle line and leave a pneumothorax externally (Fig. 6).

The roentgenogram will give us scant information as to the character of the fluid, except that the purulent fluid is likely to give a denser shadow than the serous. It requires probatory puncture to settle this question.

4. *Lung abscess.* The diagnosis of a lung abscess is more difficult. A patient may have had an encapsulated pocket of pus in his lung for months and even years before a diagnosis is made. Its location by physical examination is more difficult because it is usually centrally located and, as a rule, much smaller than an empyema (Fig. 7). The tuberculous abscess has a distinct wall and is more often multiple and therefore much more easily diagnosed than that resulting from a pneumonia or other causes (Fig. 8). When a patient gives a history of having suddenly spit up a quantity of pus and continues to expectorate purulent material, the presence of a lung abscess must be considered. After an abscess has ruptured into a bronchus, its localization becomes more difficult still, because the sac has collapsed, and a proba-

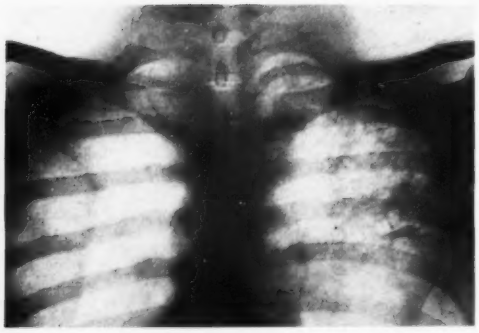


Fig. 10. Roentgenogram showing healed tuberculosis.

tory puncture will in most instances fail to strike the pus cavity.

5. *Pneumothorax.* There should be no difficulty in diagnosing a pneumothorax, as the physical signs are very characteristic, especially the hyper-resonance. The roentgenogram, however, is most convincing. We find here the absence of shadows in a well defined area which means that the lung has retracted and the space is not occupied by fluid but by air which, of course, produces no shadow whatever. Figure 9 illustrates a typical pneumothorax.

6. *Advanced pulmonary tuberculosis* with abscess will in the roentgenogram resemble very much a bronchopneumonia, showing areas of infiltration of different sizes, and thus the history and clinical findings must assist us in our diagnosis. The healed out tuberculous process, however, gives a characteristic picture, namely, an apparently transparent lung with fine linear markings, corresponding to the bronchi, with many small, distinctly outlined shadows of calcified deposits and many concrete shadows resembling snowflakes, which represent the fine scars remaining from a healed out tuberculosis. Figure 10 illustrates such a case

Probatory puncture. The probatory puncture should never precede the roentgenogram, because the latter will assist us in choosing the place for the introduction of the needle. The indiscr minate use of the probatory puncture is a dangerous procedure. One should strike the pus, if it is there, the very first time. I should not advise more than three punctures. If after the third puncture the pus cannot be found, the case should be studied further by other means.

The danger of introducing the needle consists in puncturing healthy lung and carrying the infective material into it and causing secondary abscesses. One might push the needle beyond the confines of a small abscess and thus get no result. In withdrawing the needle one should use some suction at three or four different depths. The pus at times is so thick that it will not flow through a very small calibered needle, thus a suction syringe should always be attached to the needle.

The character of the pus is of great diagnostic value. A smear preparation as well as culture should be made from the same at once and if the fluid is of serous character it should be placed in a test-tube, to see how much sedimentation will occur within 24 hours.

NON-OPERATIVE TREATMENT

The introduction of antiseptics into the fluid within the pleural cavity has been advocated for a number of years. Treatment with 2 per cent formalin and glycerine was introduced by Murphy and has been used extensively by Kreuscher, his former assistant. It is supposed to sterilize the fluid within the cavity, and is gradually absorbed, thus making its withdrawal unnecessary. It seems to produce earlier closure following drainage; one or two cases were cured without opening, and it has made unnecessary extensive thoracic surgery. It cannot be used in children or in cases with tuberculous etiology but gives its best results in empyema following pneumonia or ordinary pleurisy, after the pleuritic effusion has become purulent.[1] The chief objection to the formalin is that it produces a great deal of pain. The method is not extensively employed; the reason for this is not quite apparent.

Repeated puncture and withdrawal of small quantities of the fluid at regular intervals has been found effective by a number of surgeons at the military camps. The gradual withdrawal of the fluid by means of a syringe has the advantage of being comparatively

[1]Dr. Kreuscher's personal communication.

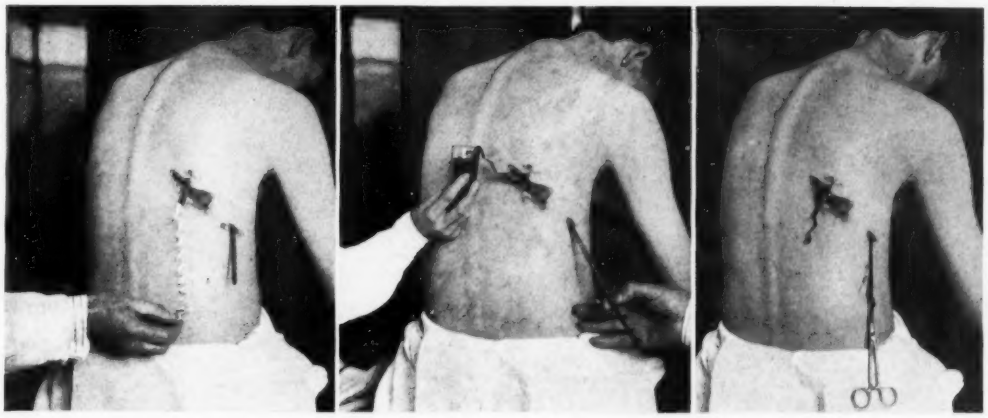


Fig. 11 Fig. 12. Fig. 13.

Fig. 11. First step. Large rubber tube removed. Tape attached to catheter, ready for insertion.

Fig. 12. Second step. Tape soaked in 20 per cent argyrol drawn through both drainage openings by removing the catheter.

Fig. 13. Tape in place, to remain until discharge ceases.

harmless but it carries an uncertainty of a final cure. We cannot hope to withdraw every drop of the pus from the pleural sac and since we are bound to leave a certain quantity, the question must arise in our mind, what becomes of the residue? Will it be absorbed? If nature is able to absorb a residue of pus, why cannot she absorb the entire quantity? The advocates of the repeated puncture method must clear up this point by citing a sufficient number of cases with control of roentgenogram comparative studies.

Vaccine therapy is too large a subject for this paper, but it must be taken into consideration. Personally I have had no experience whatsoever; there are a number of articles, some speaking favorably, others unfavorably, about this method of treatment.

WHEN TO OPERATE

During the present epidemic, we have noted that in the very acute cases of pneumonia a serous fluid, very septic in character, is frequently thrown out into the pleura and compresses the affected lung. This clear fluid will gradually assume a purulent character. If we withdraw about 10 cubic centimeters of this fluid every 24 hours and pour it into a test tube we will note that the sediment of these samples will vary. The amount of the grayish purulent material settling at the bottom of the tube will be greater each day, so that the fluid drawn on the tenth day might contain as much as 30 to 40 per cent of sediment and 60 to 70 per cent of clear serous fluid. It is, therefore, very difficult to say at what particular stage of purulization we shall regard the case as one of empyema. Experience has shown that it is not safe to operate in the acute stages when the fluid is still serous. In the report of the Empyema Commission, in charge of Major Dunham, at Camp Lee, the following statement is made:

> "Our observations force us to the conclusion not only that a late operation has decreased the risk of death but also that it has in general been followed by a less troublesome convalescence. Almost without exception the cases in which at the present time there are still large cavities are ones in which operations were performed early. Whether or not the fact that the operation was performed late or in the postpneumonic stage of the disease, has borne a direct relationship to the more rapid postoperative obliteration of the cavity, cannot be definitely answered. The observation may be only a coincidence, but yet it has been so striking as to suggest that a definite casual relationship has existed."

Whether the deduction of the Empyema Commission, namely, that the mortality is

Fig. 14. Roentgenogram showing two separate cavities on the same side: *a*, bismuth paste gravitating when patient is in sitting posture; *b*, abscess cavity in front of the apex, filled with bismuth.

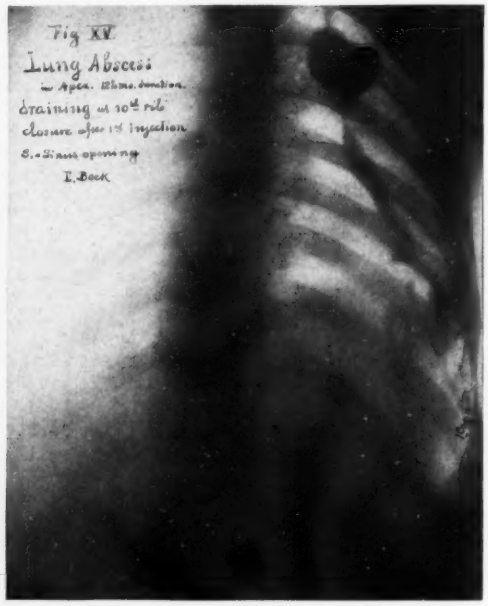


Fig. 15. Long sinus leading into the small pocket in the apex.

due to the sudden pneumothorax, is correct or not, the fact remains that very early operation is dangerous and should not be undertaken. The theory of the pneumothorax alone does not appeal to me as being the great factor in producing the death rate, because the lung had constantly been in a state of compression by the fluid previous to operation. The lung was immobilized by the fluid and the sudden withdrawal of the fluid releases this immobilization and thereby aggravates the condition because at this time the lung is still in an acute state of inflammation. Another cause which might be responsible for the mortality is the operation itself. The resection of a rib, although not very extensive, opens a sufficiently large wound surface for secondary infection and absorption of micro-organisms, which are contained in the apparently harmless fluid (but very septic, in fact usually the streptococcus). The patient has not as yet acquired sufficient immunity against this particular micro-organism. This is not entirely theoretical. It has been proven in a number of cases that where the blood cultures were free from micro-organisms just before operation, positive blood cultures could be obtained 24 hours later. I cite from the article[1] by the Empyema Commission, Camp Lee, Virginia:

"There is great danger of producing a blood stream infection, evidently because of absorption of streptococci from the surfaces of a fresh wound. That this is a real danger is shown by the fact that in two cases of early operation cultures from the blood were sterile before operation, while cultures from the blood taken 24 hours after operation showed numerous hæmolytic streptococci."

It is evident that after the fluid has become purulent, it has lost a great deal of its virulence, at least to the same individual in whose chest it has formed. In other words, it has become cold. We know from experience that the longer pus has been retained within a certain location in the body, the less virulent or toxic it is. We may therefore con-

[1] J. Am. M. Ass. 1918 Aug. 3 367.

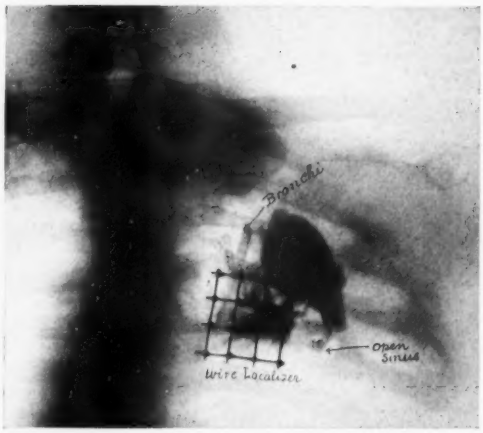
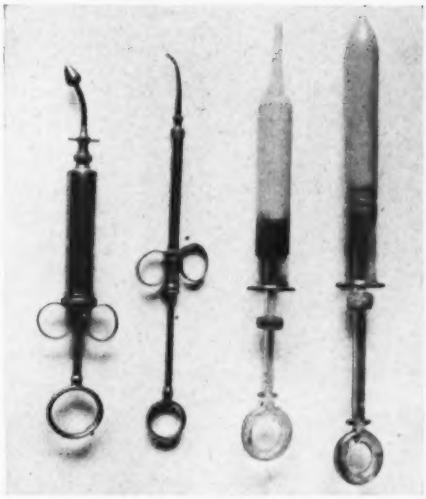


Fig. 16. Roentgenogram showing communication of abscess in the lung with the bronchus.



a *b* *c* *d*

Fig. 17. The four types of syringes generally employed: *a*, blunt tip glass syringe, employed in most cases of sinus; *b*, glass syringe with long nozzle, suitable for empyema cases; *c*, dental metal syringe used in small sinuses about the teeth and for pyorrhœa; *d*, metal syringe, olive-shaped tip, used in rectal fistula and small sinuses elsewhere.

clude, that it is much safer to defer the operation until the fluid has become distinctly purulent, although it is perimissible or even advisable to withdraw small quantities with a small cannula to relieve distressing symptoms.

CHOICE OF OPERATION, ANÆSTHESIA, DRAINAGE

The simplest operation must appeal to us as the most desirable. The method advocated[1] by Major Hugh McKenna, of Chicago, appears to be the simplest. It consists in introducing a catheter size No. 14F. by means of a trocar or cannula, just large enough to thread the catheter into the pleural cavity. As soon as the pus escapes through the catheter the cannula is withdrawn; about 100 cubic centimeters of the pus is then withdrawn by means of an aspiration glass syringe. If the pus is too thick for aspiration, a small amount of neutral solution of chlorinated soda (Dakin's solution) is allowed to run in, which dilutes the pus and renders it easier to withdraw. My reasons for endorsing this method are the following: First, the operation is so simple that the patient takes no more risk than in the ordinary probatory puncture. Second, the wound produced by this operation is so small and the catheter is hugged by the tissues so closely that an infection of the wound is not likely to take place. Third, the fluid can be withdrawn gradually—about 100 cubic centimeters every 24 hours, without allowing any air to enter the cavity, thus preventing a pneumothorax. For this reason a clamp should be placed on the catheter during intervals of evacuation. The lung is likely to re-expand gradually as the amount of fluid within the pleura diminishes. However, even this operation should not be performed in the very acute stages, while the fluid is still serous, because at that stage the lung itself is in an acute state of pneumonia and should therefore remain undisturbed. By permitting a lung which is acutely inflamed to expand, we open widely the door for death. Whether the drainage of pus in the cases thus treated will persist or whether pus will reaccumulate after closure the future only will tell. So far the reports have been very favorable but it is rather early to pass judgment.

The counter-drainage method. At the North Chicago Hospital we have during the past

[1] J. Am. M. Ass., 1918, Aug. 31, 743.

Fig. 18.

Fig. 19.

Fig. 20.

Fig. 18. Technique in injecting pleural sinuses.
Fig 19. Illustrates the application of adhesive plaster around the granulating wound.

Fig. 20. Single drainage before skin-sliding operation (Case 1).

five years employed a method of draining empyema which proved most satisfactory. It was introduced by Dr. George Dohrmann and carried out in some 30 cases, with only 1 death. (A child died suddenly on the fourth day after operation, cause unknown.) The remaining cases closed without any recurrence. The method is the following: A section of about one inch of the eighth or ninth rib is resected posteriorly under local anæsthesia. The pleura is exposed and incised about one-half of an inch. Before any pus can escape, the index finger is pushed through into the pus cavity, thus almost entirely blocking the opening against escape of pus. A curved artery foceps is then inserted along the index finger and directed anteriorly and downward to the lowest point of the empyema cavity. Pressing the tip of the forceps against the inner chest wall, between the ribs, will raise the skin and indicate the place for the counter incision, which is quite easily made under local anæsthesia by the assistant. A soft rubber catheter, No. 12 or 14, is then grasped with the forceps and pulled through. This catheter has three or four small openings in the center. A large size rubber tube is then slipped over the catheter and introduced into the drainage opening of the resected rib. This rubber tube is sewed to the skin, so as to make it airtight. A glass connecting tube is then fitted into the large rubber tube, which drains the pus into a flask, either through suction or natural gravity. The patient is allowed to sit in a recumbent position in bed immediately after the operation.

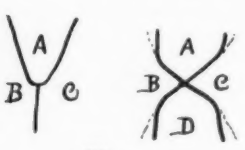


Fig. 21.

Fig. 21. Types of incision in skin-sliding operation: Y-shape incision at left: *a*, long upper flap; *b*, and *c*, obtuse lateral flaps. X-shape incision at right: 4 flaps of nearly equal size and shape.

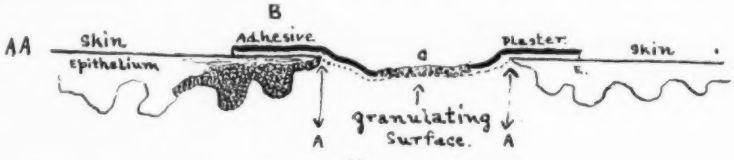


Fig. 22.

Fig. 22. Sketch illustrating the theory of the regeneration of the skin underneath the adhesive plaster: *a*, margin of growing epithelium; *aa*, normal skin; *b*, adhesive covering edges of skin and granulation; *c*, granulating surface.

Fig. 23. Microscopic section of new growth of skin two years after formation.

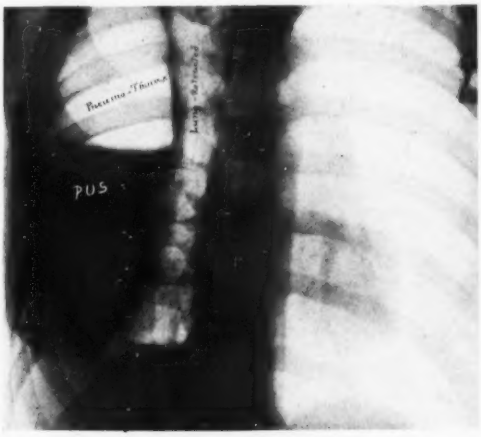


Fig. 24. Roentgenogram of Case 1, showing size of cavity, partly filled with pus. Patient in sitting posture.

Four days later the large tube should be removed; the catheter remains in place and drains from both sides for two weeks. By this time the discharge has usually greatly diminished and we are ready for a new step in the after-treatment.

A tape about one-quarter of an inch in width is attached to one end of the catheter by means of a silk thread and the catheter is withdrawn, thus pulling the tape into its place. This tape then serves as a drain for the cavity, simliar to that of a "seton." The tape is soaked in a 20 per cent argyrol solution before its introduction. This tape is left in the cavity until the discharge of pus ceases, and this has been the result in practically every case in which this method has been employed.

The three steps of the after-treatment are illustrated in Figures 11, 12, and 13.

I would place this operation second to that recommended by Major McKenna, because it is not quite as simple as his. I describe it here because the end-results of the counter-drainage operation have been so satisfactory, and should this simple drainage by means of a catheter not accomplish the final results, the counter-drainage operation would then be the one most likely to be adopted.

In regard to simple drainage such as we have been accustomed to do, I wish to offer a few suggestions: first, that the most advantageous location for introducing drainage is posterior and as low as possible, preferably the ninth rib, providing it is certain that the cavity extends that low. If the angle of the diaphragm and chest wall is obliterated by adhesions, the insertion of the tube may have to be higher and the eighth or seventh rib may be chosen of necessity, but by all means it should be done posteriorly. I recommend posterior drainage for two reasons: It is the most desirable point for draining in the lying as well as the sitting posture. Most of the chronic persistent sinuses after resection that have come under my observation, have been on the anterior chest wall, along the fourth or fifth rib, or in the axillary line, sometimes as high as the arm pit. Very few cases persist in draining when the opening has been made very low posteriorly.

In introducing a large rubber tube, care should be taken that it does not protrude too far into the pleural cavity. It it can be fixed so that it is just level with the inner chest wall, it will prevent the friction of the lung against the edge of the rubber tube. The suction method for re-expansion of the lung is to be highly recommended, but it must be done systematically and without any undue force.

Fig. 25.

Fig. 26.

Fig. 27.

Fig. 25. Condition before operation, with sketch of proposed Y-shape incision (Case 2).

Fig. 26. Skin flap, muscles and fat still attached; raised, and pus cavity opened. The floating pus is clearly seen.

Fig. 27. The cavity has been fully exposed, and the muscles and fat have been removed. The skin flap is ready for insertion.

Local anæsthesia should be employed almost exclusively. I shall not waste any time in describing the technique of resection of the rib for empyema, but I cannot refrain from mentioning one point which has been very helpful to me, namely, instead of making a straight incision over the rib which is to be resected, I make a curved incision and thus the field is opened up and the operation performed much more qucikly.

RAPID CLOSURE IN AFTER-TREATMENT

What shall be done to produce disinfection and closure of the pleural cavity in the shortest possible time?

The flushing of empyema cavities with disinfecting fluids was extensively used until about fifteen years ago. Weak solutions of permanganate or iodine or boric acid were the favorite solutions employed. The practice was then discontinued until during recent years when Doctor Carrel renewed the interest of the profession in this treatment by showing his good results from flushing infected wounds and pus cavities with what is now known as the Carrel-Dakin solution. The pros and contras for this method are very numerous. The method is on trial. Judging from the reports in the literature the results will justify its employment in the future. Personally I have had too little experience with it to justify any definite conclusions of my own. As to its technique I refer the reader to the description by the Empyema Commission[1] in its report in the *Journal of the American Medical Association.* One of the most important advantages of the use of Dakin's solution which I have observed in the cases in which I employed it, was its solvent action on fibrinous adhesions of the lung. It was noted that many cases of empyema which had recovered retained blocked-off abscess cavities due to fibrinous adhesions of the lung. The employment of the Carrel-Dakin solution dissolved these adhesions and the pus cavity was thus opened, emptying its pus into the main cavity, from which it drained freely. This, no doubt, saved a great many from secondary operations. I desire to illustrate a typical case of this nature:

A man of thirty, previous health good, became suddenly ill with an infection of his throat. Severe pneumonia followed. The temperature was 103 to 105° for 10 days, at the end of which time the left

[1] J. Am. M. Ass., 1918, Aug. 3, 372.

chest was filled with a fluid. After probatory puncture (pus with numerous streptococci), an inch of the ninth rib was resected posteriorly under local anæsthesia; a counter-opening was made at the same time anteriorly, and a large perforated catheter was introduced, passing through both openings. This drainage was kept up for two weeks. The patient improved rapidly, the pus gradually becoming thicker and more purulent. The catheter was then removed and the cavity injected with 300 grams of bismuth paste, a mixture containing 10 per cent bismuth subnitrate and 90 per cent vaseline. A set of stereoroentgenograms was taken with the patient in a horizontal position. From a single roentgenogram we would judge that the entire left chest cavity is filled with the mixture. The stereoscopic set of roentgenograms, however, definitely proves that this is not the case. We note that the mixture simply gravitated to the posterior surface of the pleural cavity, producing a shadow covering the greater part of the left chest. (Plate I.) The mixture does not fill the entire depth of the pleural space; the heart and the retracted lung are in front of it. This fact can only be visualized by the stereoscopic roentgenogram, the single plate is misleading. The interesting finding of another abscess, and proof of this is given in another roentgenogram, patient in the sitting posture (Fig. 14). The bismuth mixture has now gravitated downward and left the upper two-thirds of the cavity empty and thus transparent. The mixture accumulated at the bottom, giving a square-shaped shadow, *A*. We note, however, that a portion of the mixture has been retained in a pocket in the upper anterior portion of the chest. It evidently ran anterior to the lung at the apex. The mixture here gives a distinct outline of a locked-off abscess, with a distinct waterline mark on its upper margin, *B*. Such roentgenograms as this are essential for a correct diagnosis and greatly facilitate the treatment.

Fig. 28. Size and location of cavity outlined by injection of bismuth paste.

It will depend upon the final results whether the irrigating method will become a permanent armamentarium in the treatment of these cases. We must take into account, that heretofore we have been accustomed to promise our patients a closure of an empyema in at least 19 out of 20 cases and this was done when we treated them by simple drainage without irrigation. If the irrigating methods will produce better results than that, they will retain their place; if the percentage of discharging sinuses will be larger than before, the profession will be tempted to return to simple drainage without irrigation. We must not be misled by some adverse reports on the Carrel-Dakin solution, for it is quite possible that some did not obtain the desired results because they did not follow the technique laid down by Carrel in its finer details. If one desires to employ another man's method, he must follow it to the letter and not try to make modifications of his own. I believe this has been the case in the use of the bismuth paste method of treating sinuses. It is, of course, possible that the type of cases with which we are dealing now will not yield the same good results with simple drainage as the cases did in former years, but since there has been no trial made of simple drainage on as large a scale as that of the flushing method with Carrel-Dakin solution, the question is open to investigation.

The cases which do not yield to the flushing method should be treated with the injections of bismuth paste. It is unnecessary here to go into this method of treatment in detail, since I have, from time to time, published the technique as well as the results obtained, but since empyema is now so prevalent and the use of the paste will probably be much greater in these cases than ever before, I believe it will be of advantage to give some of the important points in the correct technique, which is so essential for the attainment of good results. The injection of bismuth paste serves two purposes, first diagnostic, second therapeutic.

Diagnostic points. The various shapes of these empyema cavities can be best visualized by filling them with bismuth paste and then taking a set of stereoroentgenograms.

Such roentgenograms will give a clear picture of the size, location, and depth of these cavities. Studying them we can define with accuracy the boundries and anatomical relations of the cavity and thus plan our operation and treatment accordingly. In some cases the pleural surfaces adhere and nearly obliterate the entire pleural space and leave a long sinus leading into a pocket not larger than a crab-apple (Fig. 15). The injection of bismuth into the sinus will likewise give a clear picture of the existing conditions. In some instances roentgenograms will show a straight channel from the skin opening in the chest wall leading directly into a bronchus, which indicates that the preexisting cavity has shriveled down to a straight sinus, but did not close on account of the communication with the bronchus.

The introduction of the catheter into an empyema for the purpose of estimating the extent or size of the cavity is not a reliable one. I prove this by exhibiting Plate II.

In this particular experiment I have introduced two catheters alongside of each other into the opening, in order to ascertain whether they will lie parallel after introduction. A view of the stereoscopic roentgenogram clearly demonstrates the fallacy of trying to ascertain the boundaries. One of the catheters runs up into the apex and makes a small curve and the other curls upon itself and points downward after it has reached halfway into the empyema cavity.

Multiple abscesses in the lung may be shown by injecting them with bismuth paste, even if they communicate with the bronchi, because they very often communicate and septa only separate these cavities (Fig. 16). I also wish to illustrate a case in which two abscesses, one above the other, distinctly outlined, which do not communicate, appear in one lung (Plate III).

To determine the presence of a communication between the abscess cavity and the bronchus the injection of bismuth paste is most dependable, because the patient will cough up the mixture. As soon as the existing cavity has been completely filled, the overflow will penetrate into the bronchus and the patient will get a coughing spell during which he will eject some of the paste. A word of caution is here necessary, namely, that the paste should in such case be injected very slowly and the patient asked not to inhale during this injection, for he may aspirate some of the mixture into the other side of the lung, while it is passing up through the trachea. It may also produce a choking spell if a large amount of the paste is forced into the trachea. For this reason the mixture must be liquid. We realize that as the trachea is several inches long and its lumen not very wide, it is very easy to clog up this lumen by a column of thick paste and the patient would be unable to inspire any air whatsoever. When there is an accumulation of pus in the abscess cavity the paste mixture will displace this pus, drive it into the bronchus, and the patient will cough up a quantity of pus before any paste will appear in the expectoration.

It is of course absolutely necessary that when a foreign body is the cause of the abscess that it be localized before any treatment is attempted. Here the stereoroentgenogram is almost indispensable for the determination of the exact location of the foreign body. An extensive study of this subject will be found in my publication entitled, "The Localization of Foreign Bodies by means of Stereoroentgenograms," published in the *Stereo-Clinic*, in 1917. Without the help of stereoroentgenograms I should have been very much handicapped. These have been a most useful adjunct in my armamentarium for the treatment of chronic empyema.

After a satisfactory anatomical diagnosis has been made by means of these roentgenograms, the next step is to ascertain the character and quantity of the discharge. In some cases it is a green, foul-smelling pus, in some a serous, semipurulent fluid resembling dirty dishwater; in others a creamy, or chocolate-colored thick pus. The color of the pus depends very often upon the substances which have been used in the treatment. Irrigations of permanganate or silver nitrate especially change the character and color of the secretion. We invariably take a culture and smear of the pus and whenever it seems necessary we inject one or two

Plate III. Two distinct abscesses not communicating; the upper containing some pus, the lower some bismuth paste. Only stereoroentgenograms will show this condition.

Plate II. Two catheters inserted into one cavity, proving fallacy of estimating size of cavity by catheter.

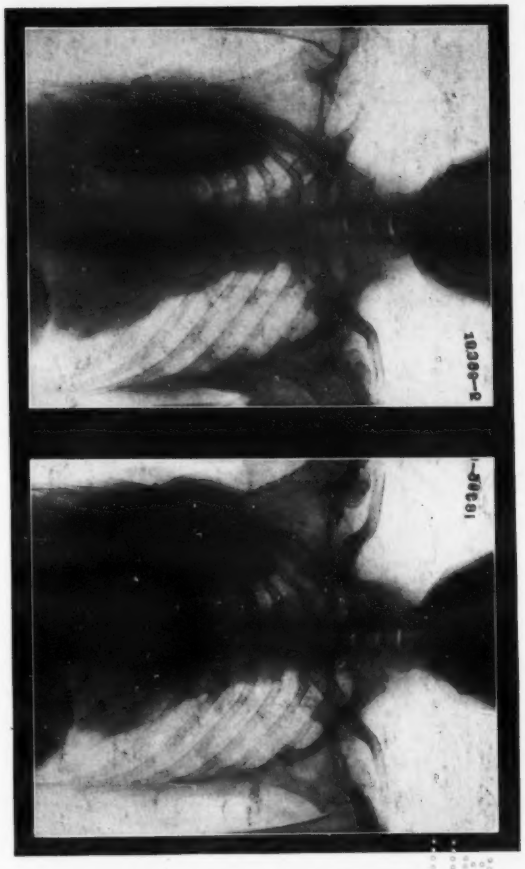


Plate I. Bismuth paste filling the posterior portion of cavity, following influenza.

Plate VI. Condition of cavity of second case five weeks after operation. Illustrating also adhesive plaster method of regeneration of skin. Note regeneration of skin on all borders.

Plate V. Regeneration of skin complete. Patient able to use the arm.

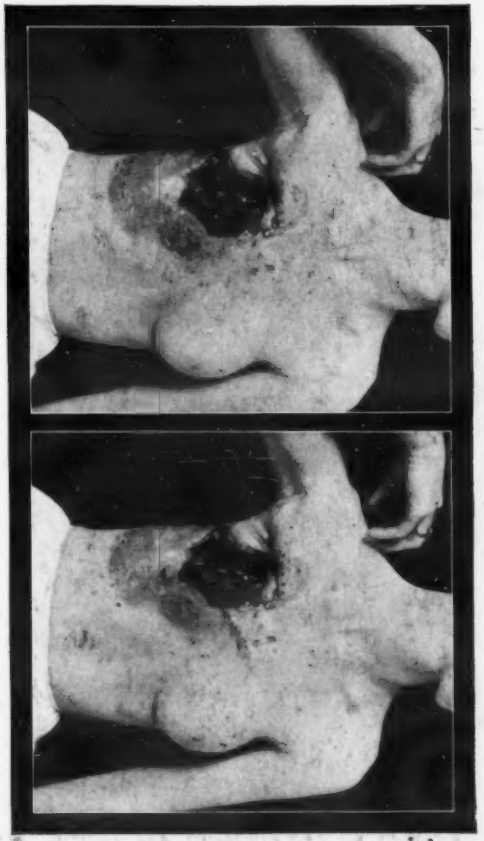


Plate IV. Condition two weeks after skin-sliding operation, showing deep cavity still granulating.

guinea pigs with a 10 per cent solution of this pus. In practically all the cases we find the staphylococcus; in addition to this we find the streptococcus in about 20 per cent of the cases. The tubercle bacillus is rarely found in the secretion, even in the cases in which the empyema is positively of tuberculosis origin.

We have made one remarkable observation in this connection, namely, that in the cases known to be of tuberculous origin in which tubercle bacilli could not be found in the secretions, the bacilli would appear after injecting the cavity with bismuth paste and were then present within 24 hours in very large numbers in each smear preparation, often as many as a hundred in each field. This surprising finding was verified in a number of cases during the past ten years. These tubercle bacilli, however, differ somewhat in their appearance and staining qualities from those which we usually find in tuberculous sputum; they are beaded, resembling somewhat a miniature chain of streptococci, staining also much darker than the tubercle bacillus usually does. The number of these bacilli gradually diminish and within 2 or 3 weeks the secretion will be free from the same.

My explanation for the appearance of these bacilli after the injection is the following: The tubercle bacilli live within the walls of the sinuses or the abscess wall and not in the secretions. It requires a local leucocytosis to provoke their exit. The injection of a substance like bismuth subnitrate produces a leucocytosis within the walls and by this means the bacilli are carried out in the discharge. I am of the opinion that the modus operandi consists in a battle between the tubercle bacilli and the leucocytes, resulting in the death of the bacilli and their expulsion into the secretions. Possibly the same may be true in the case of other micro-organisms and this would in a degree account for the surprisingly rapid sterilization of large infected cavities. I have as yet no confirmatory laboratory evidence of the above theory, but the theory seems plausible and is supported by clinical evidence.

Therapeutic points. Bismuth paste treatment. This is the most conservative and at the same time the most effective treatment of these chronic discharging sinuses of the chest. This opinion is not based alone on my own experience in over 150 cases but from reports and observations of many large hospitals in this country and abroad, as well as from my observations at the Great Lakes Base Hospital. By this time the bismuth method is well known, and the results from its employment and its dangers are well defined. After ten years of trial it has retained its place and is employed more extensively now than ever. The reports in the literature indicate that at least four out of five cases of the very old neglected suppurative empyemata or lung abscesses may be cured by this simple procedure. Ochsner, of Chicago, reported to the American Surgical Association on June 4, 1909, 14 cases of empyema, all of which had been operated upon (two by Estlander's operation) with sinuses in all cases persisting nevertheless. He applied the bismuth paste in each of these cases, with the result that 12 cases healed completely and two were still under treatment at the time and very much improved; others have reported equally good results. In my own series of 150 cases approximately 80 per cent were cured by the bismuth injection treatment alone.

Technique of bismuth paste treatment. Before the treatment is instituted a set of stereoroentgenograms of the entire chest (plate size 14x17) should be taken in order to visualize if possible the retracted lung, adhesions, thickened pleura, or discover foreign bodies if such be present. The cavity is then injected with a 10 per cent bismuth-vaseline paste.[1]

When the cavity or sinus is completely filled with this mixture, another set of stereoroentgenograms is taken. This set will illustrate the exact size of the cavity and its relation to the ribs and other structures in the chest. The second set of stereoroentgenograms shows that the cavity is entirely filled with bismuth and usually marks the inner boundary of the cavity formed by thickened pleura. The sizes and shapes of these cavities vary greatly; no two are alike.

[1] In former years I employed a mixture containing 30 per cent bismuth subnitrate, but found that the above mixture produces equally good results and is not likely to cause bismuth absorption.

The paste is not supposed to be retained in the cavity and allowed to remain there for absorption. Many have the idea that the paste serves as a filling substance to obliterate dead space. This is an error which might lead to serious complications, especially bismuth intoxication. The paste is to remain about two to five days and if it does not spontaneously escape, it should be drawn out by means of a catheter attached to a suction syringe.

In order that the mixture may be correctly prepared, I here include a formula and rules by which it has been prepared at the North Chicago Hospital for the past twelve years.

Apparatus.

1. Bismuth subnitrate, C. P.
2. Yellow vaseline (best grade).
3. White wax.
4. Large porcelain mixing bowl.
5. Spoon.
6. Large enamel jar with cover for storing paste.
7. Several small enamel jars with covers for liquefying paste at time of use.
8. Adhesive straps for the covers of the jars, to keep moisture and dirt from contaminating the paste.
9. Water bath for heating paste.
10. Sterile rubber gloves, towels, etc., for aseptic technique.

Bismuth paste is a ten per cent mixture, one part of bismuth subnitrate to nine parts of vaseline with a small amount of white wax (2 ounces to 10 pounds of paste). The mixing bowls, jars, and spoon are sterilized; the vaseline is sterilized for 20 minutes in the original container in the autoclave. The bismuth subnitrate is sterile when it comes from the manufacturer and so does not have to be resterilized. The mixing bowls and jars must be absolutely dry, as the slightest amount of water produces a curdling of the paste.

The bismuth subnitrate is poured into the mixing bowl and all lumps smoothed out with the spoon. A sufficient amount of vaseline, which is still in a liquefied condition from the sterilizing, is slowly poured into the bismuth, to make a stiff paste. This mixture is then stirred for an hour until it is a smooth, bright yellow, homogeneous paste. This is the most important step in the process and if not carried out carefully, the paste will not be homogeneous.

To the balance of the nine parts of the liquefied vaseline, a small amount of white wax, which has been heated to liquefaction is added (2 ounces to 10 pounds) and then this mixture is gradually added to the thick paste, stirring it constantly. The resulting product should be a light yellow, smooth, homogeneous paste, which, on cooling, becomes congealed without the precipitation of the bismuth.

At the time of use, small amounts of this paste (8 to 10 ounces) are transferred to small jars, in which the paste is liquefied and from which it is used. These jars should not be more than half full and great care should be taken not to get any water into the paste while heating it.

The syringes that are used are both glass and metal (Fig. 17); the barrel holding from one-half to two ounces of paste. These syringes have different shaped points and nozzles, according to the demands of the case. The syringes are sterilized and kept in sterile towels until they are to be used, when they are filled with liquefied paste.

The treatment should be controlled by repeated bacteriological examination of the secretions. No attempt should be made to irrigate the cavity before the injection. The patient should be placed in such a recumbent position that the sinus opening is on the highest level. This will allow the air to escape while the bismuth is being injected. A two-ounce syringe is filled with the liquefied paste, the long nozzle of this syringe, as shown in Figure 18, is introduced into the sinus and the paste slowly injected into the cavity. Upon withdrawal of the syringe some bubbles of air will escape. A second syringe full is introduced in the same manner and as a rule this will fill most of the smaller cavities, which is indicated by the overflowing of the mixture from the sinus. At times, however, it requires 10 to 12 ounces, or even more, to fill an empyema. No attempt is made to plug the opening for the retention of the paste. A simple sterile dressing, with a snugly fitting bandage, is applied. A greater part of the paste will escape within 24 hours.

The first injection does not always produce permanent healing. It requires at times repeated injections during several months, but whenever the discharge changes from pus to a serous character, the injection should be stopped, because healing will usually follow. Only when the discharge continues to be purulent should we consider a more radical procedure.

Causes of non-closure of drained cases. I have tried to ascertain why some cases respond to the bismuth treatment and why others do not and I have come to the conclusion that whenever the cavity holds more than 200 grams it will be less likely to heal by bismuth injections. Cases which com-

municate with the bronchi are also more resistant than simple empyema. Some cases will heal shortly after the injection and remain closed for a year or two and the patient be in good health, often gaining as much as 30 pounds, and then the sinus will reopen. The injections are then to be repeated. Closure usually follows for another year or two, and the patient may have another relapse after a long period. The patient often prefers to keep up treatment in this way, not being much inconvenienced and perfectly well in the intervals.

In studying a large series of cases which failed to close, the following causes have been found to be the factors:

1. In many cases the retracted and infiltrated lung tissue cannot expand sufficiently to fill the dead space existing between itself and the rigid chest wall. Nature tries to diminish this space by contracting the chest wall, so that the ribs almost overlap and in many cases there are no intercostal spaces except at the insertion of the ribs at the spine. The diaphragm very often is drawn up two or three inches in ts attempt to obliterate the space. The pleura also thickens and diminishes this space to a certain degree. Nevertheless there often remains a cavity holding two or three hundred cubic centimeters of fluid.

2. The pleura often contains micro-organisms which cannot be reached by flushing with any antiseptic solution, and thus the secretion of pus continues indefinitely.

3. At times there are foreign bodies present, such as rubber tubing, which has slipped in unknown to the surgeon and remained there, keeping up suppuration.

4. In cases of abscess of the lung, the tendency to non-closure is greater because there is usually a communication with the bronchus, which is very often dilated, and reinfection of the abscess cavity after drainage keeps up the suppuration.

5. These chronic suppurative abscesses are often multiple, and when one or two are opened, the drainage and suppuration persist in many small recesses, and only communicate through the branches of the bronchi.

6. In abscesses due to tuberculosis of the lung, the reason for non-closure is still more apparent when we consider the pathology of the tuberculous lobe.

Bearing in mind these various causes for non-closure, the treatment in each case will naturally consist in removal of the cause if this be possible. If the cause is not removable, as for instance, the extreme size of the pus cavity, we are face to face with a most difficult situation. The patient has then the choice either of enduring his trouble and being satisfied with daily dressings or of taking the risk of an extensive operation.

WHAT SHALL BE DONE WITH CHRONIC SUPPURATIVE CASES WHICH PERSIST IN SPITE OF TREATMENT?

During the past seven years I have employed a method of obliterating these very large cavities or those which persist in discharging on account of communication with the bronchus, which I believe is simpler and less dangerous than the extensive Estlander, Schede, or decortication of the lung. I have described the same in full in the March, 1918, number of SURGERY, GYNECOLOGY AND OBSTETRICS, p. 259, but since then I have introduced new features in this operation, and in order to make the subject here complete I will recapitulate the essential points of this rather new procedure. I am informed by a number of confrères who have already employed this operation that they have found it very satisfactory.

SKIN-SLIDING OPERATION FOR EMPYEMA

This procedure aims at the obliteration of the pleural space, as does the Estlander or similar operations. It differs, however, in this respect, that in the skin-sliding operation we transform the suppurating cavity into a skin-covered surface, so that it is a continuation of the outer chest wall, while in the other procedures an attempt is made at re-expanding the lung or caving in of the chest wall to meet the retracted lung.

This epidermization of the exposed lung is accomplished by removing as much as possible of the muscles, ribs, and the thick parietal pleura over the pleural dead space,

exposing thereby the retracted lung surface and then initiating the growth of skin over the exposed lung by shifting a long skin flap into the deepest recess within the pleural space. This skin flap will serve as a starting point for the regeneration of the skin from its edges until the entire denuded surface is covered by an epithelial growth.

The regeneration of the skin from the edges will take place only if we prevent the granulations from rising too high above the level of the skin edge, and for this purpose we have introduced the adhesive plaster method for regeneration of the skin described below.

The size and shape of the skin flap should be planned beforehand and the incision made accordingly. In most cases I have employed a Y-shaped incision, which produces really three flaps, as shown in Figure 21. Flap *A* is longer and narrower and is intended for the deep recess in the apex, while flap *B* and flap *C* have obtuse angles and will usually reflect over the dome of the diaphragm and the mediastinum. In other cases different incisions, such as the X incision or the "trap-door" incision may be more suitable. These are also illustrated in Figure 21. In order to review the technique of this operation, I cite from my previous publication:

The patient is placed in a semi-recumbent posture and is anæsthetized either by local or general anæsthesia. Before incising the skin a rubber catheter is introduced into the existing sinus and kept there as a guide.. The incision is then made to suit the individual case, choosing one of the incisions illustrated in Figure 21. The flaps at first contain the skin, fat, and muscles, in order that the skin may keep its circulation, until it is ready to be inserted. Then follows the resection of as many ribs as seems necessary to expose the lung to its fullest extent. Three to five is usually sufficient. This should include, as a rule, the third rib, because this gives us access to the deepest part of the cavity and facilitates the insertion of the flap into the same. The greater part of the pectoral muscles must often be divided or dissected to make the exposure sufficient. A straight incision is then made upward through the pleura, starting from the sinus in which we have placed the catheter and carried to the highest point possible, up to the second rib. The edges of the thickened pleura are then retracted by strong Volsellum forceps and the cavity inspected. All of the parietal pleura is now dissected away clear to the edges of the dissected ribs on either side, but no attempt is made to peel off any of the visceral pleura, or to resect the parietal pleura covering the first or second ribs at the apex. The muscles and fat are now freed from the skin flap and cut off. The tip of the skin flap is then grasped by an artery forceps and carried to the farthest point upward into the deepest part of the cavity so that its raw undersurface lies snugly against the parietal pleura underneath the first and second ribs. Gauze is packed rather tightly against it to keep it in place. In order to prevent retraction of the skin flap, the forceps may be kept *in situ* for 24 hours, the gauze packing keeping it in place. Another precaution may be taken by fastening the skin by means of a stitch taken through the base of the skin flap to the tissues over the second or third rib. It may be advisable to introduce a small drain beneath the base of the skin-flap to prevent the possibility of suppuration underneath the flap. At this stage the operation is completed. The two lower skin-flaps require no special attention; they will adjust themselves.

During the entire procedure it is rarely necessary to use any suture material. The operation should not take more than 100 minutes, in the more extensive cases, and can be done in less than 60 minutes in the less extensive ones.

After-treatment. The packing should not be removed for 48 hours. By this time the flap will be firmly adherent. It is best, however, to take the precaution to keep a spatula in contact with the skin flap, so that it will not be torn off in removing the gauze. The removal of dry gauze may sometimes be so painful as to necessitate a gas anæsthesia and for this reason we introduce at the second dressing gauze strips which have been soaked in vaseline. Within one week the raw surfaces, including those which have been caused by the denudation of the skin, will be covered

sufficiently by granulations to begin the application of adhesive strips for skin regeneration. The method is as follows:

The zinc oxide adhesive plaster as an aid to skin regeneration. This consists in pasting adhesive plaster strips about a half to three-quarters of an inch in width, along the edges of the granulating wounds, so that the margin of the skin, as well as the granulation surface is covered (Fig. 19). The adhesive plaster serves the same principle that wire does for a vine; the granulations will be kept down to the level of the margin of the skin and the epithelial cells will regenerate along the under surface of the adhesive plaster (Fig. 22). On removing the first dressing of the adhesive strips we will note a bluish margin along the edges of the skin, which represents the new growth of cells during the twenty-four hours. The adhesive plaster is not put on at the next dressing but plain gauze is applied, in order to give the newly formed growth a chance to become more substantial. Thus the adhesive plaster is applied every second dressing, or every forty-eight hours, alternating with gauze dressings.

It has been questioned whether a true regeneration of epithelial cells takes place, since some of the new formed skin resembles scar tissue. We have proved beyond doubt that true regeneration of epithelium does take place, which proof will be published in a special article. However, we here wish to illustrate the microscopic sections of some of the newly formed skin removed from cases in which we performed secondary operations in which epithelial regeneration took place (Fig. 23).

For illustration of the skin-flap operation I desire to cite two typical cases:

CASE 1. *Chronic empyema*, 10 years' duration, with drainage. Miss F. L., age 19, developed an empyema on the right side at the age of 9. This was drained and she was apparently well until she was 14; then she developed fever and pain in the right chest. The chest was reopened and large quantities of pus evacuated, whereupon the wound healed up again. Shortly after, fever again developed and it was then advised to drain permanently as shown in Figure 20.

She came under the care of my brother, Carl Beck, in June, 1915. Injections of bismuth were tried for a time and the condition improved but the cavity was so extremely large that a permanent obliteration could not be expected. (Fig. 24.) Therefore, on February, 1916, Carl Beck performed a modified Schede operation. A circular flap and the muscle were dissected down to the ribs and a part of the fourth, fifth, sixth, and seventh ribs was resected anteriorly. The pleura was then incised at the seventh rib, where drainage had been established, and the incision continued up to the third rib. The cavity was packed with several pieces of gauze and the wound temporarily closed with three stitches of catgut.

The second step of the operation was done ten days later and this consisted in trying to obliterate the space by pressing in the right breast. This procedure, however, was not found effective, since the cavity itself reached far into the apex, and besides the pleura was constantly secreting pus. He therefore decided to denude the skin from the breast, making a large-size flap, amputating the breast and the pectoral muscles and shifting the skin flap up into the apex. This was done in May, 1916. No attempt made to produce lateral flaps.

The entire denuded area was left uncovered for the adhesive plaster method of reconstruction of the skin (Plate IV). Healing took place rapidly and with the aid of adhesive plaster the entire cavity was now lined with skin, entirely dry, and the girl is in perfect health and able to do general housework. She has no deformity of the spine, only the unsightly depression in her right chest wall (Plate V), which of course is only visible when she is undressed.

CASE 2. *Chronic empyema*, draining 3 years, complicated with acute influenza-pneumonia.

A Bulgarian laborer, S. K., age 33, developed empyema in 1915, and drainage was performed two weeks after an illness which was probably pneumonia. This left a small sinus draining anteriorly, as shown in Figure 25.

The previous treatment of this case consisted in irrigations and also injections of bismuth paste (Fig. 28), which improved it for six months, during which time the sinus was closed and then reopened. It was finally decided to do a skin-sliding operation. A Y-shaped incision was made, such as is shown in Figure 25. The two principal steps in the operation are illustrated in Figures 26 and 27. The first one illustrates the resection of the skin flap, including the muscles (for those are not to be removed until the skin is to be shifted into the cavity), the pleura is already opened and we notice the floating pus within. In the second we have already dissected away the muscles and widely exposed the pleural cavity. The skin flap here is being held up by two forceps. This upper flap was inverted and pushed against the under surface of the remaining chest wall, thus adhering to the parietal pleura. The entire cavity was then packed snugly with gauze, to keep the skin in close contact with the pleural surface and favor adhesion.

Subsequent history. The patient did very well for five days. On the fifth day he developed all the symptoms of influenza, the epidemic in the meantime having begun in Chicago and a number of the nurses as well as patients having contracted the disease. The temperature rose to 105° and 106° within 24 hours and all the symptoms of an acute pneumonia in the exposed lung developed. We could watch the inflammatory condition by ocular inspection. The thickened pleura which covered the lung at the time of operation became now a transparent, succulent membrane with a whitish covering, congested blood-vessels, and in some portions dark spots like gangrenous areas were developed. Twenty-four hours later a hæmorrhage took place from the surface of the lung, which was controlled by the application of Monsell's solution and the lung was tightly compressed with gauze, which was kept in place by adhesive plaster.

We could now observe the progress of the disease during the daily dressings. Hæmorrhages took place during the dressings sufficient to be alarming. The patient, however, did not succumb to this affection. After two weeks he began to gain, the lung gradually changing to its former appearance and granulations forming around the edges of the lung.

I illustrate in Plate VI. the present condition, the case being still in the hospital. Regeneration of the skin is taking place rapidly, so that I expect a complete and similar result as in the former case cited.

COMMENTS

This method of treatment of apparently incurable empyemata is still in the developmental stage and will no doubt be developed to greater perfection, but I am certain that it has a great many advantages over the extensive operations which have heretofore been performed for this condition.

Since there is no suturing done in this operation after the resection of the rib and excision of the pleura, the operation is completed in one-half the time that we would require in the Estlander. We are finished with the operation just about the time when we would expect to have the greater part of the work before us.

SUMMARY

1. The treatment of empyema has, through the occurrence of new types, become a new problem and on account of its enormous prevalence will require a revision and modification in methods of treatment.

2. The correct treatment of the early stages will prevent the majority of the chronic suppurative sinuses.

3. When sinuses persist in spite of all previous treatment the bismuth paste, if correctly applied, will eliminate approximately 80 per cent of such cases.

4. The residue of such cases as are not amenable to the bismuth treatment may be cured by the skin-sliding operation, provided the technique is followed as outlined in this paper.

PERFORATED GASTRIC AND DUODENAL ULCERS[1]

By H. M. RICHTER, M.D., F.A.C.S., Chicago

THE treatment of perforated duodenal and gastric ulcer is a settled problem to most surgeons; to the student of the literature of the subject it becomes obvious that each has settled it in his own way, and that the solutions arrived at have little in common except the necessity for closing the perforation. Based on a personal experience of 17 cases, and a study of some 50 odd cases operated upon in Cook County Hospital in a period of five years, the writer offers the following suggestions:

1. The peritonitis resulting from a gastric or duodenal perforation is but slightly if at all infective during the first hours following the accident and, therefore, it must not be treated as a suppurative process.

2. The degree of patency of the pylorus after closure of the perforation alone does not determine the indication or otherwise for a gastro-enterostomy.

3. The operators's technique, quite irrespective of the method he uses, determines in a high degree, his mortality.

The peritonitis. The normal stomach and duodenum are practically sterile much of the time. In the presence of an ulcer this is not the case, but the amount of infective material present must usually be very slight. It is a very common experience, borne out by the histories of the cases here studied, that many of the patients give no history suggestive of any degree of pyloric obstruction. Not rarely the perforation is the first evidence of the presence of an ulcer; usually the history is that of an active ulcer of the type likely to be accompanied by a hyperacidity and rapid emptying of the stomach. The ulcer itself is an infective process; but the stomach contents are practically sterile and when emptied into the peritoneum produce the violent reaction of a chemical irritant. Some years ago I published a report of a case in which there was a widespread fat necrosis, and some experimental work in which I succeeded in producing a typical widespread fat necrosis by making a perforation of the duodenum. Several of the cases in the series studied in this paper present such a peritonitis with fat necrosis. All this reaction is, however, a chemical reaction; it calls for mechanical emptying of the peritoneal cavity. The one thing that logically is to be avoided is the leaving of gauze or tubes in such a peritoneum for drainage. Such drainage must surely entail the danger of infection to the already badly damaged peritoneum. Where actual solid masses of food are present, an incision in the midline below should be made of sufficient length easily to investigate the more dependent parts of the abdomen and remove them, or, if too numerous, and the condition of the patient forbids, drainage may here be instituted. But this is an exceptional occurrence. It has not occurred in my own experience, though the perforation often follows the ingestion of food, and some particles may be found in the peritoneum. When it is remembered that in the vast majority of cases, the perforation is very small (less than 5 millimeters in diameter), it will be readily understood that the expression "the peritoneum was full of food" is usually imaginative rather than descriptive. That drainage cannot materially aid the escape of solid food masses, and that in my cases recovery occurred without such drainage, must be regarded as evidence of a positive value of the uselessness of the attempt to drain. Drainage instituted because of the presence of solid food masses must be regarded rather as a safety factor in the event that suppurative peritonitis should develop; but since the gauze and tubes will surely be walled off from the free peritoneal cavity many hours before the development of the suppuration that they are intended to relieve, the futility of the procedure must be obvious. In my earlier cases, in which I was accustomed to drain, I was struck by the obvious ineffectiveness of the procedure. Data are lacking as to the exact time elapsing between the perforation and the operation, but among those personally

[1]Read before the Western Surgical Association, Chicago, December, 1918.

operated upon one was twenty-five hours old. Among the records of Cook County Hospital, several cases are included in which the perforation was a number of days old; in these instances the perforation must have been incomplete giving time for walling off processes to develop. Here actual suppuration might easily have been present and drainage of the local abscess justified.

First, then, I should conclude that drainage is almost always uncalled for in early perforations of gastric or duodenal ulcers. Drainage may be instituted (1) in late cases (after 18 hours); (2), the rare instance of inadequate closure of the perforation due to physical inability adequately to invert the lesion; and (3), where gross masses of stomach contents are spilled into the peritoneum.

Gastro-enterostomy. Is a gastro-enterostomy called for after closing a perforated ulcer? Diametrically opposite views are presented in a most arbitrary manner. Deaver always does a gastro-enterostomy; others never do a gastro-enterostomy. It seems to me that gastro-enterostomy has a double function to perform; first and obviously to relieve existing obstruction due to the inversion of the ulcer, and second, and of fundamental importance, the therapy of the existing lesions in the stomach.

First of these, the relief of obstruction, applies only to duodenal and pyloric ulcers. When *adequately inverted*, these should almost always produce obstruction. It is no evidence of skill that such an obstruction is avoided; rather it is frequently an evidence of inadequate inversion of the calloused ulcer. Moreover, that clinical patency is found to be present, when at operation obstruction seemed likely, is evidence only that the stomach is capable of compensating for a high degree of obstruction, *which it should not be called upon to do*, as we hope to show.

The therapy of the existing stomach lesions. It is agreed that the perforation is one of the surest cures for gastric ulcers. It is a cure for the ulcer involved in a limited number of cases (70 per cent — Paterson); but in from 20 per cent to 50 per cent of the cases of active ulcer causing perforation, the lesion is multiple. The autopsy findings at Cook County Hospital are incomplete on this phase of the subject; the only patient of my series who came to autopsy showed seven active ulcers; two besides that which perforated were extensively necrotic, four were in various stages of activity. The value of jejunostomy in such a case can hardly be overestimated; not merely its late effect, but its immediate action on the perforation and on the active ulcers.

There is a note in some of the records that the stomach wall is found too friable for suture. Such a statement is evidence that the operator lacks a proper apprehension of the principles underlying the closure of a perforated ulcer. The perforation is but a small portion of the gross ulcer. In closing the perforation the entire ulcer should be embedded. It is for this reason that the lumen of the pylorus and duodenum will usually be closed if an ulcer is adequately enfolded.

Excision of the ulcer. Excision of the ulcer, its closure with free facial transplants, the cauterization of the perforation, etc., are all unnecessary complications of the technique of treatment. In the presence of an emergency fraught with danger, these unnecessary additions to the operation are uncalled for. Through-and-through suture grasping the entire ulcer as well as the perforation is effective in destroying the lesion.

THE OPERATOR'S TECHNIQUE

Technique, after all, plays an important part in results, irrespective of the type of operation followed. Although there is found to be a benign peritonitis during the early hours following the perforation, the abdominal viscera will not withstand excessive traumatism. Whatever operation is done, it must be carried out with a minimum of handling of the parts. The statement, "contents poured from the perforation while the stomach was being drawn from the abdomen" is evidence of poor technique. The rate of traumatism per minute inflicted upon a patient if it could be indicated by a definite unit of measurement would surely be found to vary 1,000 per cent in the hands of different operators, and this materially influences results. A further evidence that the operator's technique plays

quite as important a rôle in mortality as his method of treating the perforation, is indicated by the fact that several series of perforations have been reported in which the mortality was low, though some were treated by gastro-enterostomy and others not. Examples of this are Deaver's statistics of 40-odd cases with one death, in all of which he did a gastro-enterostomy, and the work of others, in which gastro-enterostomies were not done, and in which the mortality was almost equally low. The elements of technique which play an important rôle in the mortality may be covered in a few words: First, the incision should be ample to afford the operator easy access to the upper abdomen. The pyloric end of the stomach and duodenum must be so exposed that they can be viewed *in situ* with a minimum of disturbance. Such an exposure enables the operator to find the perforation without loss of time, and, what is more important, without pulling the parts out of their normal position.

It is said to be difficult at times to find the perforation, and it has been suggested to give methylene blue in order to facilitate locating it. In three cases among the 50 operated upon in Cook County Hospital it is noted that the perforation was not found during the operation. I have had no experience of this kind, and I think it likely that a free exposure would practically obviate its occurrence.

Upon locating the perforation, if leakage is taking place, a finger should be placed upon it until a through-and-through running suture can be so placed as to whip it in. There is no occasion for any special type of suture. The object is immediately to close the leak. The perforation and the ulcer, of which it is a small part, should now be thoroughly infolded with as many sutures as are required adequately to accomplish the purpose. When the perforation lies close to the pylorus and the area of induration is wide, it may be desirable to turn the first portion of the duodenum acutely upon the stomach and suture it there. The essential step at this part of the technique is to bring good broad peritoneal surfaces together. Fowler's position, nothing by mouth, and the use of large quantities of water per rectum constitute an important part of the after-treatment.

Of the 17 cases personally operated upon drainage was instituted in 6 or 7 of the cases, being used in all of the earlier cases. In all but one instance where drainage was used it was through an extra suprapubic incision. In one case drainage was carried down to the perforation itself. In this case the perforation opened up within 48 hours and all stomach contents were discharged almost as quickly as swallowed. The patient died within a few days, and this constituted the only operative death in 16 consecutive cases. In one case in which drainage was not instituted a subphrenic abscess formed, followed by a pleural empyema. This patient died in the fourth week following operation, after making a prompt primary recovery. The extension of the infection to the pleura was probably due to inadequate drainage of the subphrenic abscess. The seventeenth case of the series died of a generalized peritonitis. Examination at autopsy showed the presence of seven active gastric ulcers.

ARE WE JUSTIFIED IN REMOVING A COMPARATIVELY HEALTHY GALL-BLADDER[1]

By W. H. MAGIE, M.D., F.A.C.S., Duluth, Minnesota

THIS short paper is based upon my personal experience in three hundred operations upon the gall-bladder and bile-ducts.

There has been, and still is, quite an animated discussion going on as to the relative value of cholecystostomy and cholecystectomy. There is no doubt that both methods of securing the same result have their advantages in properly selected cases. While looking over the literature of surgery of the gall-bladder, one is impressed with the wide difference of opinion existing among different authors. There is no department of surgery in which there is a greater difference of opinion than in surgery of the gall-bladder.

My object in presenting this paper is to make a plea in favor of saving the gall-bladder in at least a majority of the cases. The physiologists as well as surgeons are of the opinion that the gall-bladder has a function, and when we admit it has a function, we are compelled to admit that function, whatever it may be, should be conserved. It is claimed that its chief function is the storage of bile and that the bile, while in the gall-bladder, undergoes certain chemical changes that better fits it to participate in the processes of digestion and that at certain intervals this bile is discharged into the duodenum. These intervals correspond with the early stages of digestion. Again there is another theory, more recently put forward, concerning an additional function of the gall-bladder; that it acts as a pressure gauge keeping up the intrabiliary pressure. That the gall-bladder has a function of storing bile there can be no doubt. I have never seen an empty or collapsed gall-bladder when examining it during the course of operations in the upper abdomen. The fact that it is always filled with bile goes to prove that it has much to do with keeping up and regulating the pressure in the bile-ducts and liver. This theory is supported by the results of experiments upon animals. Eisendrath and others, have shown that when the gall-bladder is removed in dogs the remaining cystic duct dilates as do the common and hepatic ducts. The dilatation of the cystic ducts takes on the appearance of nature making an effort to reproduce the gall-bladder. This same dilatation of the cystic duct has been observed in man after cholecystectomy. This effort of nature to reproduce the gall-bladder is evidence that the gall-bladder not only has the function of storing bile, but also has a pressure regulation function upon the biliary system. These facts should be taken into consideration where the question of cholecystectomy versus cholecystostomy, is to be decided.

Some years ago, while discussing the relative merits of cholecystectomy versus cholecystostomy with one of the most popular surgeons of this country, he made the statement that "every gall-bladder that could be saved, should be saved; that removing the gall-bladder is like burning the bridges behind an advancing army; that it was valuable for drainage purposes especially in cases of cholecystitis accompanied by cholangeitis with swelling and plugging of the hepatic ducts as well as the common and cystic ducts with tarry bile."

Two years ago, while visiting this surgeon at his clinic, I saw him remove what looked to me very much like a normal gall-bladder. In reply to my question as to what percentage of gall-bladders he removed, he stated, "about 97 per cent." This answer was a very unexpected one, although I knew that his mind had greatly changed during the intervening years. The more we study statistics of gall-bladder surgery, the more confused we become, due to the fact that there is a wide difference in results even among the very best surgeons in our country, as well as surgeons of the countries across the Atlantic. To account for this wide difference of opinion is impossible. One class of surgeons has ability

[1] Read before the Western Surgical Association, Chicago, December, 1918.

and experience equal to that of the other class, but still results are very widely apart. How can we reconcile these widely divergent results? Probably, as in the case of the surgeon who informs me that he had to reoperate about one-third of his cholecystostomies, he left many gall-bladders that should have been removed at the first operation.

The first object we wish to obtain in many of these cases is the saving of human life, as many of these cases are very seriously ill when they reach the surgeon's hands. When to operate in many cases is a very important question and the outcome will depend on a decision as to the most opportune time for operation. An inopportune time for operation may account for the great difference in the percentage of mortality reported by different surgeons.

One of the most remarkable things I have observed is the great recuperative power the gall-bladder possesses. In my early experience before we were removing as many gall-bladders as we are now, we were astonished to see a great majority of our empyemic gall-bladders get well and stay well after drainage. If such results can be obtained from empyemic gall-bladders, we surely can expect a mildly diseased one to recover and become again a functioning organ.

It is generally conceded that cholecystectomy has much greater mortality than cholecystostomy. If so, then this consideration also should bear weight in making up our decision. Personally, I have had no mortality in my cholecystostomies, while on the other hand, my mortality following cholecystectomy has been about the average mortality, if not greater than that of other surgeons.

Recognizing the fact that the gall-bladder is not a vital organ and that man seems to get along very well without it, it still may be true that our patient does not get along so well without it as if he had it still functionating. Owing to the great difficulty in following up our cases, this question is often a very hard one to decide. The facts are that we have no means of knowing how much better off a patient might have been, if the gall-bladder had not been removed. Again, as to the morbidity following cholecystostomy, we encounter a wide difference of opinion. One surgeon makes a statement that "fully one-third of his cases treated by cholecystostomy had to be reoperated upon;" others have put the percentage of reoperated cases as low as 5 per cent. In my own experience, my cholecystostomy cases have not required reoperating in more than 5 per cent, and in every case where reoperation was necessary, it was on account of overlooked stones or stricture of cystic duct. In case of overlooked stones, the gall-bladder was simply reopened and stones removed and drained as before. In case of cystic duct obstruction, either an anastomosis with the duodenum was made or the gall-bladder removed.

I am of the opinion, that long-continued drainage followed with daily irrigation of the gall-bladder, after the removal of the drainage tube, contributes greatly to the thorough and complete cure of the pathological condition. Irrigation is also desirable for the purpose of washing out any overlooked stones that may have been left. I have on several occasions washed out, or at least have had stones present themselves at the gall-bladder sinus, as large as a good-sized marble, when they were easily removed. That drainage also has a good effect in the cases complicated with cholangeitis, when the ducts are clogged with thick tarry bile, there can be no doubt.

What are the indications for cholecystostomy? In the writer's experience, all cases of acute cholecystitis of only a few days' duration; also some cases of acute cholecystitis that have had previous attacks, provided the gall-bladder walls are not much thickened and free from adhesions that would indicate previous serious attacks, provided also, that the cystic duct is open and gall-bladder contains bile. Many acute gall-bladders contain but little bile at operation, due to swelling of cystic duct but within a day or two after drainage is established and sufficient time has elapsed for the swelling to have been reduced, the bile escapes freely through the drainage tube. All cases of simple cholelithiasis, when gall-bladder shows little signs of ever having been infected and when exploration of the interior shows a comparatively healthy mucous membrane.

When should cholecystectomy be resorted to? (1) In all cases of hydrops with stricture of the cystic duct; (2) in many cases of acute gangrene or threatened gangrene of the gall-bladder; (3) in all cases complicated with imbedded stones in the cystic duct with ulceration produced by contact with the imbedded stone that when healed would probably cause stricture; (4) in all very thick-walled gall-bladders due to fibrous or calcareous degeneration; (5) in all cases of ulceration due to pressure of large stones; (6) in cancer of the gall-bladder where the disease is limited to the gall-bladder.

PAROTITIS AS A POSTOPERATIVE COMPLICATION[1]

By CLIFFORD U. COLLINS, M.D., Peoria, Illinois

IN the year, 1915, four of our patients developed parotitis and three of them died. This was considered a sufficient reason for making a study of the subject, which was done. The things that were learned from that study seemed to be valuable, because we have had only two cases of parotitis since, both postoperative, and neither one died.

First, we went over our records and found that in six thousand one hundred patients who had been operated on, seven had developed parotitis, and one patient developed parotitis and died while waiting for operation. A study of these cases was made which follows.

All of these eight patients had been in the same hospital, which had no special significance, we thought, because practically all of our operative work is done at this hospital. Five were males and three were females. All of these eight patients had had abdominal operations except one and he had an abdominal infection, peritonitis following appendicitis. Three were operated on for obstruction of the bowels, two were operated on for ulcer of the stomach, one had a panhysterectomy done, and two had peritonitis. Two of the patients had fæcal fistulas and one had a colostomy when the parotitis developed. In five patients both glands were inflamed and in three patients the right gland only was affected. Five patients died while three recovered. Of the five that died three had abdominal conditions that might have caused death anyway, but in two of the five patients the parotitis was evidently the principal cause of death.

In six of the patients there was no positive evidence of suppuration in the glands. Two recovered without suppuration and four died. Of the four that died, three died in such a short time after the parotitis developed that there was hardly time for suppuration to become manifest. In two of the patients suppuration became apparent and the glands were drained.

It was deemed significant that seven of these patients had had abdominal operations and the other one had an abdominal infection, peritonitis. The seven patients operated on had received scopolamine $\frac{1}{100}$ grain and morphine, $\frac{1}{6}$ grain as a preliminary hypodermic before the operation. As is well known scopolamine dries up the secretions of the mouth and salivary glands. But one patient had not been operated on and had not received scopolamine. So evidently scopolamine was not a factor in the production of parotitis in that patient. All of the patients had been on the Ochsner treatment and nothing had been administered by the mouth for several days. An effort had been made to supply these patients with sufficient water by administering salt solution and bicarbonate of soda solution per rectum.

After a study had been made of our case records a study was made of the literature. Nearly all of the cases of post-operative parotitis reported in the literature followed abdominal operations. This seemed to be significant.

[1]Read before the Western Surgical Association, Chicago, December, 1918.

One of the most interesting articles we found was by H. B. Rolleston and M. W. B. Oliver.[1] They studied 1000 cases of gastric ulcer treated in St. George's Hospital in twenty years from 1889 to 1908. These patients were all treated medically and not surgically. In 470 patients treated by oral starvation there were 21 cases of parotitis or 4.5 per cent, while in 530 patients who were allowed something by mouth there were two cases of parotitis or 0.4 per cent. These two patients were on rectal feeding but had been allowed to suck a little ice. It should be noticed that these patients were suffering from an abdominal condition, gastric ulcer, that food and drink had been interdicted by the mouth in practically all of them, and none of them had been operated on. It is evident therefore that some factor other than something pertaining to a surgical operation was a cause of the trouble in these patients. The authors sum up their conclusions as follows:

"1. Secondary parotitis may complicate cases of gastric ulcer treated medically by oral starvation.

"2. That it occurs ten and a half times more frequently in such cases of gastric ulcer than in cases allowed fluid by the mouth.

"3. That it is an outcome of the dry condition of the mouth and that mouth washes do not prevent its recurrence.

"4. That it is more often unilateral than bilateral.

"5. That suppuration occurs in about one-fourth of the cases and that this constitutes a grave complication."

Curiously enough there is an article in the same journal by W. S. Fenwick entitled, "The Prevention of Parotitis during Rectal Feeding."[2] He believes that the infection ascends Stenson's ducts. He tried various measures to keep the mouth clean during the rectal feeding but they were not successful. Then he made an effort to promote a continuous flow of saliva by having the patient chew horse radish, pieces of raw meat at intervals, or keep a pebble constantly in the mouth. He finally had the patients suck an India rubber teat about two inches long which produced the desired effect. He said the patients sucked the teat for hours at a time and thus kept the mouth clean and moist. After he adopted this method he treated more than 300 cases of hæmatemesis by rectal alimentation without being troubled in a single instance by parotitis.

An article by Jacob Frank[3] discusses the different theories and sums up as follows:

"1. That it is highly probable that secondary parotitis is due to an ascending infection of Stenson's duct.

"2. That the onset of this complication may be prevented by attending to the following details: (a) mouth carefully cleansed before and after operation; (b) everything used for the anæsthetic should be sterile; (c) the anæsthetizer should avoid pressure on the gland while attempting to elevate the jaws during anæsthesia.

"3. When the swelling does not show any tendency to decrease in size, in about four days, it is advisable not to wait for fluctuation, as the location of the pus is beneath the dense parotid fascia. Therefore, free incision and drainage should be resorted to early."

From the study of our cases we are inclined to agree with Frank's conclusion, that the cause is usually an ascending infection from the mouth. All of our patients had been on the Ochsner treatment and fluids had been withheld by the mouth. Two of our patients had a fistula of the small intestine which allowed the liquid contents of the small intestine to escape before the fluid portion was absorbed. Both of these patients died. We became convinced that the parotid glands in our patients had become inactive because nothing had been taken into the mouth to excite activity of the gland, and that this inactivity predisposed the gland to infection. We also became convinced that our patients had not received enough fluid and this further contributed to inactivity of the parotid glands and dryness of the mouth. A study of the practical results of trying to give fluids per rectum convinced us that the patient did not get near as much fluid by that method of administration as we had tried to make ourselves believe that he did. When we put good

[1]Brit. M. J., 1919, May 29.
[2]Brit. M. J., 1909, May 29.
[3]Surg., Gynec. & Obst., 1912, xiv, 469.

honest nurses in charge of the proctoclysis and received honest reports we found that about half of the patients retained very little, if any, of the fluid. The remaining half of the patients retained perhaps half of the amount of the fluid administered. After two or three days' administration the rectum usually becomes irritable and retains none of the fluid. At least this has been my experience, and I would like to know whether I am alone in this experience.

So we decided that our first problem was to keep the parotid gland actively secreting and passing a current of secretion down Stenson's duct into the mouth, and our second problem was to keep the patient's body supplied with sufficient fluid.

In solving the first problem we tried the use of chewing gum but it did not seem to work well. Perhaps the ingredients of the brands of chewing gum defeated our purpose. At any rate we discarded chewing gum after a trial with it. Then we tried letting the patients chew on a rubber nipple following the suggestion made by the English author quoted above. While we were doing this a colleague called attention to the fact that acids excited the parotid gland secretion, as evidenced by the diagnostic measure of having a patient suspected of having mumps try to eat a sour pickle, and suggested the use of acids. We then tried putting a lemon drop in the nipple. Finally we gave the patients old-fashioned lemon stick candy to suck and that gave the best results. Whenever it is deemed best to withhold food and drink by the mouth for a time as in stomach operations, peritonitis, or paralytic ileus, for example, the patient is given a stick of lemon candy to suck but not to eat. It excites a flow of saliva and keeps the parotid gland active. Obervation has seemed to show that there is not enough secretion swallowed at one time to excite peristalsis of the stomach or bowels. At least the patients did not complain of peristaltic pains while using the candy.

The second problem of supplying the patient with sufficient fluid was solved by following the suggestion of Kanavel[1] and putting the hypodermoclysis needles in the axillæ, and leaving them *in situ* as long as necessary in order to save the patient the pain of reinsertion. A pint of normal salt solution may be given every three or four hours in this manner, and you know that the patient's body receives the entire amount of the fluid. We have left the needles in four or five days and the patients did not complain of discomfort. Incidentally, we believe that in our practice this measure has saved lives in other conditions as well as postoperative parotitis. Sometimes we keep the solution going continuously through the needles into the tissues for several hours.

If the inflammation has not been prevented by the above means, a free incision with adequate drainage should be instituted early, in about four days, if the inflammation is not subsiding by that time. The capsule or fascia covering the gland is so dense that it takes a long time for the pus to work through and give evidence of its presence on the surface of the skin. It usually works along beneath the fascia and breaks into the external auditory canal.

Vilray P. Blair[2] makes a plea for the early institution of surgical treatment on the third or fourth day, and shows a cut of the incision he uses. He claims that this incision heals spontaneously with a hardly noticeable scar. This incision has been used by the writer a few times and the results so far corroborate the claims of Blair.

CONCLUSIONS

1. Postoperative parotitis is more apt to occur after abdominal operations than operations on any other part of the body.

2. Its development is favored by a dry condition of the mouth and a lack of fluids in the body.

3. The infection usually ascends through Stenson's duct.

4. In patients whose abdominal condition makes it necessary to withhold food and drink from the mouth and stomach for a time, prophylactic treatment should be instituted.

5. The mouth should be kept clean and moist by its own secretions and the body should be abundantly supplied with water.

[1]Surg., Gynec. & Obst., 1916, xxiii, 483.

[2]Med. & Surg., 1917, March

6. A good way to excite the secretions of the mouth and to keep a current of saliva flowing *down* Stenson's duct is to allow the patient to *suck* on a stick of lemon candy after operation.

7. A very accurate and effective way to supply the body with fluid is to administer salt solution by hypodermoclysis. If this is done according to Kanavel's directions, there will be no pain in the administration and very little discomfort.

8. If the prophylactic treatment fails and parotitis develops and the inflammation is increasing, or is no better by the third or fourth day, the gland should be uncovered by a free incision and punctured in several places with blunt forceps and the incision packed with wet sterile gauze as suggested by Blair.

OBSERVATIONS REGARDING THE INDICATIONS FOR THE OPERATION OF CRANIAL DECOMPRESSION

By WILLIAM SHARPE, M.D., New York
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THE operation of cranial decompression has been so frequently misinterpreted and even confused with other cranial operations that it seems advisable to state its indications and contra-indications, and to describe the type of decompression with its most satisfactory technique.

As is indicated by the name of the operation, a cranial decompression presupposes the presence of an increased intracranial pressure; if there is not present an increased intracranial pressure then the operation cannot be described as a decompression, but rather as a craniotomy (if the bone-flap is replaced), or a craniectomy (if the bone-flap is permanently removed). In the recent literature, the term decompression is commonly used to indicate merely a trephine opening, and in may instances the dura not even opened or allowed to remain opened; surely a small trephine opening in itself with the dura opened may theoretically be, to a certain extent, a decompression, but its decompressive effect is practically almost negligible; again, to replace a bone-flap even though the dura is allowed to remain open is not a decompression because the decompressive effect of the operation is nullified. It would seem, therefore, that the three qualifications essential to a cranial decompression (in order that it be correctly considered as such) are:

1. The presence of an increased intracranial pressure.

2. The removal of a large area of the vault —usually 3 inches in diameter.

3. The dura to be opened and allowed to remain open; as the dura is inelastic in adults, no decompressive effect can be obtained unless the dura is opened, and if a permanent decompression is desired, then the dural opening must not be resutured but allowed to remain open.

Cranial decompressions were commonly performed in the past over the upper areas of the vault. Many disasters resulted from this prodecure; in fact, the operation of cranial decompression for this reason was practically discredited and it remained an operation of the last resort until Cushing placed the operation upon a rational basis. In patients having a marked increase of the intracranial pressure as in brain tumor, not only was the operative damage to the underlying, highly developed cerebral cortex a frequent result of such decompressions situated over the upper portions of the vault and thus followed by paralyses, impairment of the special senses, and only too frequently the immediate death of the patient, but the insecure closure of the operative wound (merely covered by the scalp) permitted huge herniæ cerebri to occur and only too frequently their end-result, fungi cerebri and the death of the patient after months of a vegetative existence. It is no surprise therefore that a few years ago the operation

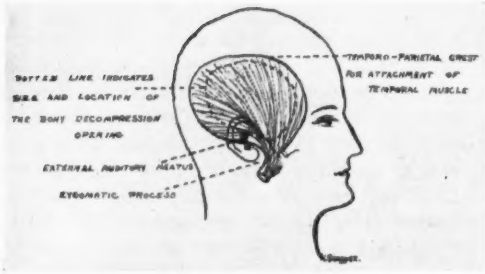

Fig. 1. The anatomical relations of the right temporal muscle with its attachment to the parietal crest above and to the inferior maxilla beneath, the zygoma below. Its diameter is usually 3 inches and more in adults, and forms ideal protection for the bony decompression opening.

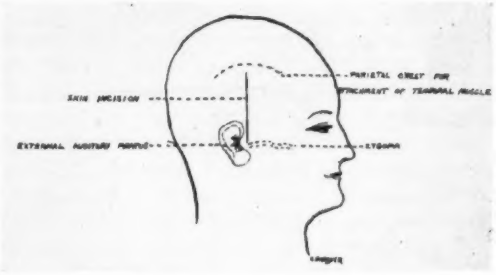

Fig. 2. The vertical skin incision of about 3 inches extending from the zygoma upward to the parietal crest and no higher—a very important factor in obtaining a firm closure.

of cranial decompression was avoided as long as possible—even at the risk of the delay producing an impaired vision and even blindness itself, and it is this transmitted dread and fear of cranial operations that have retarded the development of brain surgery possibly more than any other factor. Cranial operations as now performed, are no longer such extreme risks while the operation of cranial decompression is in itself no greater risk than the usual abdominal operation. This advance is due chiefly to better team work of the surgeon and the neurologist, a more practical conception of the purpose of the operation of cranial decompression, and then a most important factor, an improved surgical technique.

The operation of cranial decompression may be considered as a means solely of decompression, then of decompression plus exploration, and lastly of decompression plus drainage. The following intracranial conditions as benefited by the operation of decompression may be classified briefly as follows:

A. Decompression alone.

1. Brain tumors.
    1. Irremovable tumors.
        a. Large midbrain and basal tumors.
        b. Large subcortical tumors, the removal of which would produce grave impairments, such as paralysis.
2. Selected cases of cerebral spastic paralysis due to an intracranial hæmorrhage at birth.

B. Decompression and exploration.

1. Brain tumors—non-localizable tumors, usually situated in the frontal and temporosphenoidal lobes.
2. Brain abscess—non-localizable abscesses—usually situated in the temporosphenoidal lobes.
3. Selected cases of organic epilepsy—Jacksonian in type or associated with increased intracranial pressure.

C. Decompression and drainage.

1. Brain injuries with or without a fracture of the skull.
2. Hydrocephalus—either of the internal or of the more common external type.
3. Brain abscess.
4. Early localized meningitis especially due to otitic infections.

There are several other intracranial lesions for which the operation of cranial decompression has recently been advocated, notably the condition of apoplexy. It is possible in rare and selected cases of cortical apoplexy alone, and at times in ventricular hæmorrhage (although the diagnosis and operative drainage should be almost immediate in order to have the patient survive), that the operation of cranial decompression and drainage might be considered in order to obtain the greatest ultimate improvement, but to advise this operation for the usual form of epilepsy—the internal capsular type, which occurs in 90 per cent of these patients—is a most unsurgical procedure; not only do these latter patients not have an increased intracranial

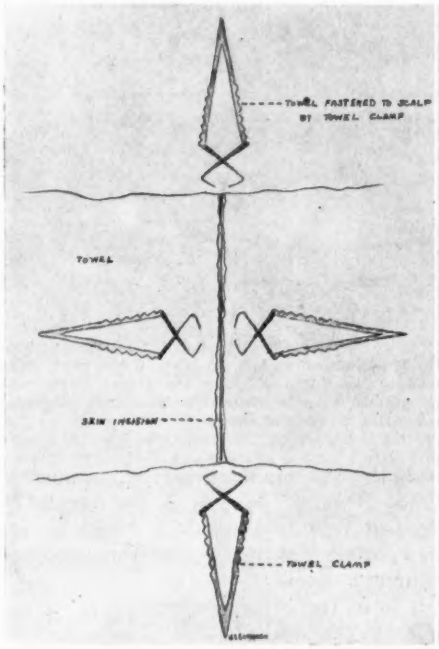

Fig. 3. The method of covering the skin (and thereby lessening the danger of infection) by clamping the towels to the skin itself; a wider exposure of skin is not only not necessary but is dangerous. The lobe of the ear cannot be made surgically clean.

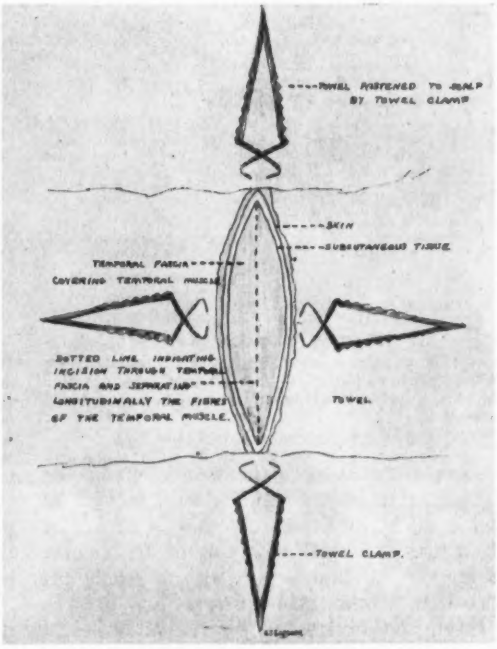
TOWEL FASTENED TO SCALP BY TOWEL CLAMP
SKIN
SUBCUTANEOUS TISSUE
TEMPORAL FASCIA COVERING TEMPORAL MUSCLE
DOTTED LINE INDICATING INCISION THROUGH TEMPORAL FASCIA AND SEPARATING LONGITUDINALLY THE FIBRES OF THE TEMPORAL MUSCLE.
TOWEL
TOWEL CLAMP.

Fig. 4. The skin incision down to the underlying temporal fascia. By the method of manual traction-pressure upon the edges of the scalp incision, the bleeding is practically nil; small curved hæmostats are now attached to the subcutaneous fascia and any possible bleeding points are compressed by the hæmostat being turned down.

pressure and therefore the operation described in the literature cannot be a decompression, but the operative damage resulting from the attempt to insert a needle into the internal capsule drain the hæmorrhage (even if it would drain) would be far greater than the impairment caused by the lesion itself; besides, some of the patients reported have been operated upon late when no drainage of the hæmorrhage would be possible; and even in the early cases operated upon, it must be remembered that the hæmorrhage into the internal capsule is not a free one, but it is enmeshed among the capsular fibers giving the appearance almost of liver tissue, and surely such hæmorrhage cannot be drained. To advise, therefore, a cranial operation upon such patients merely because medical treatment has not caused a marked improvement is surely not rational surgery.

There may be selected cases of acute cerebral œdema due to such toxic causes as occur in uræmia and certain other toxic conditions where, after medical treatment has failed, a cranial decompression might be advisable to lessen a high intracranial pressure and thus to a certain extent, spare the vision and avoid a medullary compression and its resulting œdema—always fatal. No cranial operation however, should be considered in these patients until repeated lumbar punctures have been proven inadequate. This work, however, is only in the experimental stage, and must be considered as a possible aid only in very selected cases.

The cranial decompressions of choice are the subtemporal decompressions for supratentorial lesions and the suboccipital decompression for infratentorial lesions. Naturally, the subtemporal decompression as a decom-

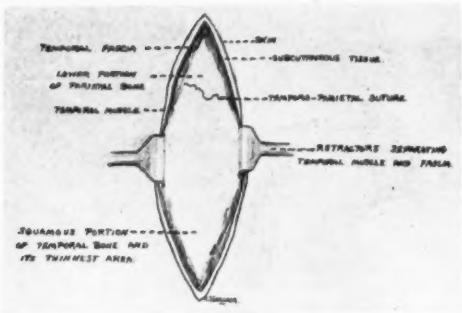

Fig. 5. The retraction of the temporal muscle and fascia exposes the underlying lower portion of the parietal bone and the squamous portion of the temporal bone; an area of bone of 3 inches in diameter can thus be exposed and removed.

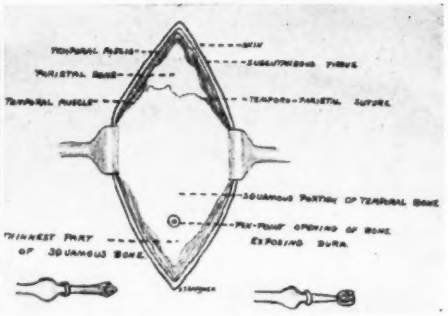

Fig. 6. At the thinnest part of the squamous bone the Doyen perforator, is used to make a pin point opening down to the dura, and then the Doyen burr, enlarges the opening down to the dura so that small rongeurs can be inserted to remove the bone.

pression alone is of little or no benefit for infratentorial lesions and should never be used in such conditions unless as a means of ventricular drainage (as in case of ventricular blockage); infratentorial lesions such as cerebellar tumor and abscess are always more effectively treated by the suboccipital operation of decompression, exploration and drainage. In this paper, however, the term cranial decompression means the subtemporal operation—the most satisfactory and effective method of decompression for supratentorial lesions; the vertical incision alone is used. (The advantages of this method of cranial decompression are detailed at the end of the paper.)

Let us consider briefly the three main purposes of the subtemporal decompressions:

A. PRIMARILY AS A MEANS OF LESSENING AN INCREASED INTRACRANIAL PRESSURE

1. *Brain tumors.* As the percentage of malignancy in brain tumors is high (almost 80 per cent), they naturally form a very discouraging part of brain surgery; then again, if the tumor is not malignant in itself, yet it may be so situated in the mid-brain or base that to remove it would either cause the immediate death of the patient or such a marked mental, physical or sensory impairment that it would not be justifiable; that is, the condition of the patient might be worse than before the operation. It is not creditable to brain surgery to remove the tumor (even if benign) if the mental and physical condition of the patient is worse than before the operation—the patient remaining a derelict.

It is in these very patients that, in order to lessen the headache and to save the vision, an early subtemporal decompression on one side and, if necessary, on both sides of the skull is most strongly to be advocated. Not only will the general condition of the patient be improved and blindness avoided, but the tumor may not continue to enlarge and may remain stationary and even become smaller apparently, and thus the patient be spared indefinitely; this is particularly true in young adults—the diagnosis being a tuberculoma of the mid-brain; the œdematous "wet" brain of the so-called pseudo-tumors might be also included. To allow these patients with a high degree of "choked disc" to develop a secondary optic atrophy and its resulting blindness merely because the tumor is considered an irremovable one or cannot be localized is an opinion that cannot be too strongly condemned. The operation of cranial decompression is no longer such a formidable procedure that it should be delayed and postponed until the life itself of the patient is endangered; to operate upon these patients blinded by long-continued intracranial pressure is most depressing and possibly hardly justifiable.

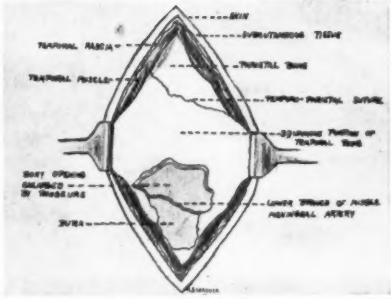

Fig. 7. (at left). Bony opening being enlarged by rongeurs backward, downward, and upward, but not forward, until last, on account of the middle meningeal artery lying adjacent to the anterior portion of the bony exposure. If the artery should be torn the hæmorrhage can be very easily controlled either with bone wax, a silver clip, or, if necessary, by a small packing of gauze tape.

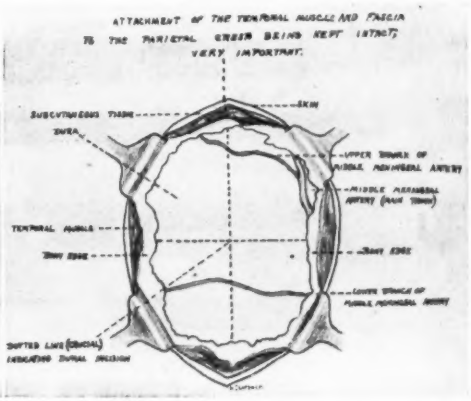

Fig. 8. Final size of bony opening, about 3 inches in diameter. The underlying dura is now opened as widely as possible by crucial and later stellate incisions. The dural hook and grooved director are first used, then the spoon spatula and dural scissors to enlarge the dural opening.

2. *Selected cases of cerebral spastic paralysis due to an intracranial hæmorrhage at birth.* These patients were formerly classed in that large group due to Little's disease and thus confused with cases of lack of development of the cerebral cortex and its pyramidal tracts, and also with those cases resulting from a former meningo-encephalitis—an infectious destructive process and naturally conditions which cannot be benefited by any cranial operation. But patients having a spastic paralysis due to an intracranial hæmorrhage at birth, not only can be differentiated by the presence of an increased intracranial pressure as ascertained both by the ophthalmoscope and more accurately by a measurement of the pressure of the cerebrospinal fluid at lumbar puncture by means of the spinal mercurial manometer, but those latter patients can be markedly improved by a lessening of this increased pressure by means of a simple subtemporal decompression. Naturally, only those patients having an increased intracranial pressure can be benefited and are therefore the only ones that are operated upon; out of a series now of almost 1800 patients that I have personally examined only 378 of them revealed the presence of an increased intracranial pressure, that is, about one out of every five patients examined, and these are the only ones for whom a cranial decompression can be of any benefit. The best results are obtained when the condition is diagnosed at the time of birth or shortly after it—and it very easily can be by the presence of blood under pressure in the cerebrospinal fluid at lumbar puncture; then, a modified cranial decompression with drainage of the free hæmorrhage will in many cases obtain a normal child. (Even repeated lumbar punctures with drainage may suffice if the intracranial hæmorrhage is not too large and the pressure too high; in these latter cases, of high intracranial pressure the cranial operation of opening the parieto-squamous suture combined with a modified subtemporal decompression and drainage is advisable; the dura must always be opened.) The older the child, the less is the improvement that can be ultimately obtained by the operation of merely lessening the increased intracranial pressure resulting from the earlier hæmorrhage; frequently a mild secondary external hydrocephalus results in these patients from the blockage of the stomata of exit of the cerebrospinal fluid in the cortical veins and sinuses; this condition can be drained accord-

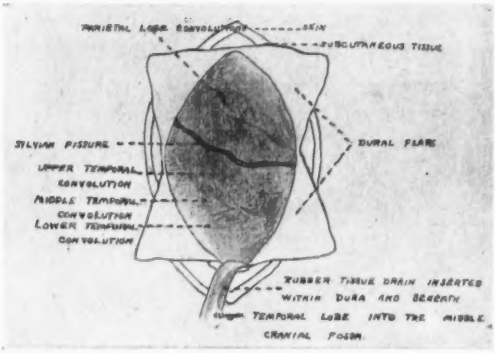

Fig. 9. (at left). The dural flaps opened showing the underlying cerebral cortex of the lower parietal lobe and upper portion of the temporosphenoidal lobe. Hæmorrhage and excess cerebrospinal fluid can thus be removed and a "waterlogged" brain be decompressed. A rubber tissue drain is inserted at lower angle of incision, as indicated.

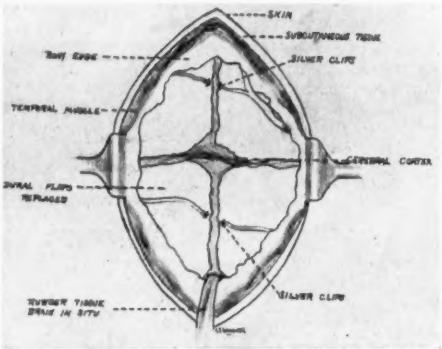

Fig. 10. Dural flaps replaced but not sutured so that a permanent decompression results. The silver clips can be seen clamping the meningeal branches in the dura. The rubber tissue drain is left *in situ*. Closure of the incision is now begun.

ingly at the same time by a modified decompression operation (vide Hydrocephalus).

The pathology of intracranial hæmorrhage in the patients is very instructive. It was formerly believed that the hæmorrhage always caused a primary destruction of brain tissue and therefore, no regeneration being possible, that these patients were all hopeless. As permission for a postmortem examination is obtained before operation upon each patient, it has been very surprising to ascertain, either at the operation or at autopsy, that the intracranial hæmorrhage caused a primary destruction of brain tissue in only 26 patients out of 364 patients operated upon; that is, in only 7 per cent. The death-rate of these operations was only 38 out of the series of 374 operated patients—that is, a mortality of only 10+ per cent, and a postmortem examination was made in each case. The hæmorrhage is almost always a supracortical one with later cystic formation, so that the mental and physical impairments in these patients are due to the increased pressure of the overlying lesion—both a general and a localized increase of the intracranial pressure. It is the lessening of this increased intracranial pressure in these selected patients that permits a marked improvement in them, both mentally and physically.[1]

[1] Internat. Clinics, 1917, iii, series 27.

B. DECOMPRESSION PLUS EXPLORATION

1. *Brain tumors.* Infratentorial growths are more easily localized than are the ones situated above the tentorium, so that if the former cerebellar tumors can be excluded, then it is a question of ascertaining the cerebral hemisphere in which the lesion is placed; at times, the clinical signs point very clearly to the location in the hemisphere, and yet only too frequently it cannot be definitely and accurately elicited; these are the patients who should not be permitted to develop a secondary optic atrophy and even blindness itself while an accurate localization in the hemisphere is being sought; an early subtemporal decompression will not only lessen the intracranial pressure but it will afford a practical means of locating the lesion by exploratory punctures—it being possible to explore carefully the entire ipsolateral hemisphere; if the tumor is found (and it very frequently is found in the comparatively silent area of the temporosphenoidal lobe directly beneath the subtemporal incision so that it can be removed immediately), then the proper method of removal can be used, and if the tumor is not found (also unfortunately, a frequent occurrence) then a decompression has at least been performed, the headaches improved and the vision spared so that a later localization of the tumor

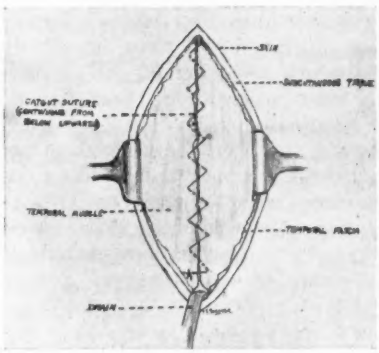

Fig. 11.

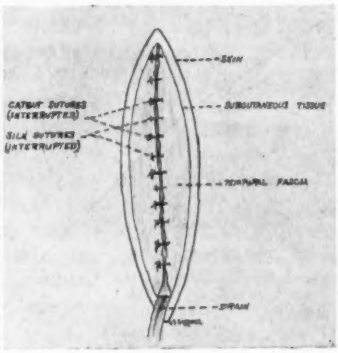

Fig. 12.

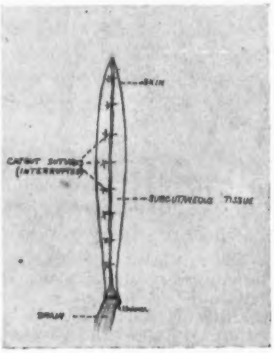

Fig. 13.

Fig. 11. Continuous catgut suture (from below upward) is used to approximate the fibers of the temporal muscle over the bony opening.

Fig. 12. Interrupted small black silk sutures alternating with the interrupted catgut sutures for closure of the temporal fascia, making a firm approximation possible. The silk sutures are permanent sutures and prevent an opening of the incision if the catgut sutures should be absorbed too early.

Fig. 13. Subcutaneous fascia sutured with interrupted catgut; continuous catgut (loosely) may be used in children in order to hasten closure in special cases.

may occur and its removal be possible and—the patient not blind. The lateral ventricle may also be tapped with a ventricular puncture needle to ascertain whether it is dilated or not; if dilated then the tumor would necessarily be either basal posteriorly or even subtentorial; ventricular drainage temporarily might be instituted to improve the general condition of the patient until the tumor, if subtentorial, could be removed. To perform large osteoplastic "flap" operations over the parietal lobe in search of a tumor which may not be present even in the underlying hemisphere, and if present, then possibly at the base or in extreme frontal or occipital portions and very frequently in the lower portion of the temporosphenoidal lobes—situations requiring another incision and removal of bone in order to approach the tumor—such tremendous bone-flap operations should never be performed unless it is surely known that the tumor can be removed through the incision; if the tumor is not found and the intracranial pressure is high, then great difficulty will be encountered in making a firm closure without causing a definite damage to the more highly developed parietal cortex; in these cases a simple subtemporal decompression would permit an accurate localization of the tumor—whether frontal, occipital, parietal, temporosphenoidal or basal—and then the tumor could be removed later through the appropriate incision.

2. *Brain abscess.* The great majority of brain abscesses are cerebral and situated usually in the temporosphenoidal lobe adjacent to the ear involved—otitic disease being the most common cause of brain abscess formations. As in brain tumors, infratentorial cerebellar abscesses are more easily diagnosed than the supratentorial temporosphenoidal ones, so that if cerebellar abscess can be excluded, then the operative approach of choice is through the "clean" subtemporal area and not through the "dirty" infected field of the mastoid incision; all drainage operations for brain abscess are really exploratory procedures, as the abscess may not be present or not found, and if the dural incision has been made through the infected mastoid area then the danger of causing a diffuse meningitis is very great indeed. If, however, the subtemporal exposure has been made and if the abscess is not found, then at least a decompression has been performed and the danger of a meningitis is slight, and if the abscess is found, then it can be freely and safely drained through the lower angle of the subtemporal incision. Not only does the decompression incision

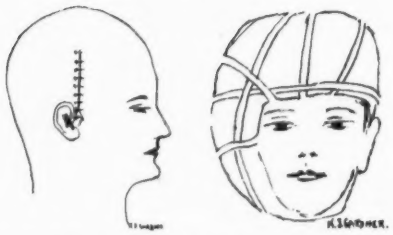

Fig. 14. (at left.) Final closure of skin incision with interrupted small black silk sutures. Drain allowed to remain *in situ* for one or two days, according to the drainage of blood and cerebrospinal fluid.

Fig. 15. Roller bandage of sterile gauze applied to head and firmly anchored by several adhesive strips. A small cotton pad placed behind the ear lobe prevents its painful compression against the head.

afford better drainage for the deeper subcortical abscesses by means of the double glass tubes, but the opportunity afforded of locating these deep abscesses is much greater and easier through the wider exposure of the decompression incision.[1]

3. *Selected cases of epileptiform convulsions —Jacksonian in type or associated with an increased intracranial pressure.* The surgical treatment of organic epilepsy is most discouraging, and no cranial operation should ever be advised in cases of long standing in the belief that the condition can be cured. In only very selected cases of short duration where the attacks are definitely of the Jacksonian localizing type and where there is a marked increase of the intracranial pressure (still persisting after an interval of at least three months has elapsed since the last attack), is the operation of cranial decompression and exploration or any cranial operation justifiable; even in the most carefully selected cases the results are not encouraging, and yet good result and apparently even a cure is occasionally obtained in these patients. Cranial surgery, however, cannot be said to offer much hope to these patients, except possibly to these very early selected patients as described above. To operate upon old chronic cases of whatever severity is hardly justifiable. Even the removal of the primary cause of the cortical irritation with its resulting convulsions—such as a cortical tumor, old depressed fracture of the vault and the cyst formation due to a former supracortical hæmorrhage may result in only a temporary cessation of the convulsions in the older patients; but these patients should be diagnosed early, the irritating lesion removed and then the outlook is not so gloomy; besides removing the lesion itself, it is always wiser in these patients to relieve permanently the intracranial pressure due to the resulting cerebral œdema of trauma by means of a subtemporal decompression.

[1] The Laryngoscope, St. Louis, 1914, March.

C. DECOMPRESSION PLUS DRAINAGE

1. *Brain injuries with or without a fracture of the skull.* The mortality of brain injuries with or without a fracture of the skull has been notably decreased within the past decade; the former death-rate of 50 per cent and even higher has been reduced in several hospitals to 30 per cent and even lower. This marked improvement is due to a more general appreciation of the important factor of increased intracranial pressure in these patients and if present, then the most satisfactory method of relieving it by means of the subtemporal decompression. As is well known, it is not the fracture in these cases nor the hæmorrhage in itself that is so dangerous, but rather the presence of a high intracranial pressure—whether due to hæmorrhage or œdema—and its consequent medullary compression and the only too frequently resulting medullary œdema that render these cases so serious—not only as to life but also to their future normality.

Formerly, the treatment of these patients had been so discouraging that it became a commonly accepted belief that they would all "get along just as well without operation as with operation." This statement is perfectly true for over one-half of the patients—there being no increased intracranial pressure in practically this percentage, and naturally no operation (except in depressed fractures of the vault) would be indicated; but of the remaining patients upon whom a cranial operation was performed, the resulting high mortality—in many hospitals being 80 per cent and even higher—was due chiefly to the operative method used—in almost all

cases the extensive osteoplastic "flap" operation being performed and the dura very frequently not even being opened (and therefore no real decompression possible) or a small and totally inadequate trephine opening—the size of a one-half dollar piece and even smaller being considered as a sufficient operative procedure—these two operative extremes—the former tremendous operation of great risk to these seriously injured patients and the latter so-called operation of no possible, or if possible, then of very slight benefit to the patients—these two operations were usually performed either during the period of initial shock within a few hours after the injury when it is now realized that no operation should ever be performed as it is merely an added shock to the patient and takes away the patient's chance of surviving the shock, or the operation was performed during the terminal period of medullary œdema in the hope that the patient would be given a chance to recover; these patients when they have once reached this stage all die—operation or no operation. Naturally, under these conditions, the operative mortality was very high. More recent observations, however, in a series of over 500 patients, have confirmed a growing belief in the following cardinal principles in treating brain injuries with or without a fracture of the skull:[1]

1. All depressed fractures of the vault should be elevated or removed for fear of later complications, particularly epilepsy.

2. The presence of a fracture in patients having brain injuries is not an important factor in their treatment; the patients most seriously injured very commonly have no fracture at all, and conversely, the less serious of brain injuries are frequently associated with tremendous linear fractures of the vault—an important channel however of lessening an increased intracranial pressure by the drainage of free blood and excess cerebrospinal fluid or œdema, and thus a cranial operation be avoided. Naturally, basal fractures into the middle ear and especially into the nasal and pharyngeal cavities may permit an infective meningitis, and yet this grave complication is comparatively rare.

3. The expectant palliative medical treatment of quiet, ice helmet, catharsis and liquid diet is sufficient for over one-half of the patients having little or no increase of the intracranial pressure.

4. A marked increase of the intracranial pressure (as revealed in slightly over one-third of these patients by the ophthalmoscope and the measurement of the pressure of the cerebrospinal fluid at lumbar puncture by means of the spinal mercurial manometer) and *not* by the late and extreme pressure signs of medullary compression (such as a pulse-rate of 50 and lower, Cheyene-Stokes respiration and pulse, a high blood pressure and profound unconsciousness) should be lessened by a cranial decompression and drainage—not necessarily at the site of the fracture if present and by no means over the upper cortical areas, but rather by means of the subtemporal decompression—the safest and most effective means of decompression, drainage and closure, possible in these patients. The dura must always be opened (except in the cases of simple extradural middle meningeal hæmorrhage which are rare) and allowed to remain open for a permanent decompression and drainage of the consequent traumatic cerebral œdema so common in these patients. If the intracranial pressure is extremely high, then a bilateral subtemporal decompression and drainage may be necessary—apparently in about 5 per cent of patients.

5. There are two periods in the treatment of these patients when no operation is advisable—no matter how seriously the patient is injured nor how high the intracranial pressure may be; these periods are—first, the stage of initial shock immediately following the brain injury when the pulse-rate is 120 or higher; any operation during this period of traumatic shock is merely an added shock to the patient and takes away the patient's chance of surviving the shock; if, however, he does survive the shock, then he does so in spite of the operation; and the second period in which no operation should be performed is the stage of medullary œdema—the terminal moribund period—operation or no operation; when once the pulse has reached its lowest level of medul-

J. Am. M. Ass., 1916, lxvi, May 13.

lary compression and then begins to ascend rapidly to 100, 120, 140 and higher, then an operation does not "give the patient a chance" (as formerly advocated), but merely hastens the exitus. If these two periods in the operative treatment of brain injuries are avoided and the latter of these—medullary œdema—usually can be anticipated, then the mortality of brain injuries will be decreased to 30 per cent and even lower, while the operation of decompression and drainage will cause not only the recovery of patients as to life but also as to their future normality.

2. *Hydrocephalus*, both of the internal and also of the more common external type. A diffuse meningitis is the usual primary cause of this condition; if the ventricles are blocked by exudate or adhesions in the aqueduct of Sylvius or at the foramina of Majendie and Luschka, then the internal type of hydrocephalus results, but if this ventricular blockage does not occur yet a hydrocephalus of the external type develops because the cerebrospinal fluid cannot be excreted as normally through the cortical veins and sinuses on account of their blockage by the former meningeal exudate.

In the operative treatment of hydrocephalus either of the internal or external type, it is obvious that to drain merely the blocked cerebrospinal fluid of the ventricles into the subarachnoid or subdural spaces, by means of corpus callosal punctures or tubes, would, even if these openings remained patent, only change an internal hydrocephalus into an external one—with resulting little, if any, impairment The object therefore, of all operative procedures in these patients is to drain continuously and permanently the blocked cerebrospinal fluid beyond the cerebrospinal canal—that is, into the blood stream (the ideal method and not yet practicable permanently) or into the extradural tissues, such as the subcutaneous tissues of the scalp, rich in lymphatics. The subtemporal decompression permits such drainage of the ventricles when blocked and of the subarachnoid and subdural spaces (in the more common type of external hydrocephalus) by means of several linen strands extending from the ventricles outward through the temporal lobe (a comparatively silent area), and from the subarachnoid and subdural spaces outward beyond the opened dura into the subcutaneous tissues of the scalp in a stellate manner.[1] At present, this method of drainage through the subtemporal decompression assures an excellent drainage to all but apparently the most severe types of internal hydrocephalus; naturally, the earlier the operation is performed following the development of the hydrocephalic condition, the greater is the chance of the child to approximate normality.

3. *Brain abscess.* As stated above, the usual type of brain abscess situated in the contiguous temporosphenoidal lobe following otitic disease is most safely and effectively drained through the lower angle of a "clean" subtemporal decompression by means of double glass tubes, so that the inner tube may be used to drain the abscess while the outer tube remains always *in situ*, and thus the abscess, when once found, is not lost. Apparently, a large decompression opening tends to lessen the danger of a complicating meningo-encephalitis—almost always fatal, whereas the opening through the "dirty" field of the mastoid not only increases the danger and lessens the opportunity of a careful exploration of the adjacent brain in search of the abscess, but it does not provide a satisfactory and efficient drainage for the deeper subcortical brain abscesses; again, to puncture the dura blindly with a knife through the mastoid opening or any dural exposure is most unsurgical.

4. *Early localized meningitis.* Similar to brain abscess formations, localized meningitis must frequently results from pre-existing otitic and sinus disease; cranial fractures are also another common cause. Here again, in the early patients, in whom lumbar punctures do not reveal the presence of an active organism in the cerebrospinal fluid and therefore indicating that the meningeal infection has not yet become a diffuse process, the operation of subtemporal decompression and drainage will offer a definite chance of recovery—although the prognosis is most unfavorable; it seems that in only the early

[1] Am. J. M. Sc., 1917, April.

and still localized conditions of meningitis will the operation be of any benefit.

The technique of the operation of cranial decompression is described briefly in the accompanying sketches; the vertical incision and not the former curved one is most satisfactory.

The advantages of this subtemporal decompression are the following:

1. It exposes, as widely as necessary, a comparatively "silent" area of the brain, the temporosphenoidal lobe, and therefore any operative damage to the exposed cortex will not appear clinically; also, in patients having a high intracranial pressure the danger of a hernial protrusion of a highly developed area of the brain with resulting paralysis, etc., cannot occur.

2. Being situated midway between the frontal and occipital lobes, it permits the careful exploration of all parts of the ipsolateral hemisphere; ventricular puncture is also possible.

3. It exposes the area of the middle meningeal artery so frequently injured in the traumatic cases, and also affords excellent drainage to the middle cranial fossa at its lowest point—a very important factor in the treatment of brain injuries.

4. A firm closure of the decompression opening is obtained by means of the strong temporal muscle and its overlying fascia with their strong attachment to the parietal crest *intact*—a most important requisite in patients having a high intracranial pressure; hernial protrusions with their frightful fungi are most rare.

5. Technically, the operation is less difficult than other cranial operations in that the skull opening is made through the thinnest portion of the vault—the squamous portion of the temporal bone.

6. The vertical incision is preferable to the former curved one in that it renders more possible a careful hæmostasis of the scalp by means of the method of manual pressure—traction and the clamping of the main branch of the temporal artery at the very beginning of the operation, whereas the curved incision passes through the various branches of the vessel in the scalp and they must be clamped individually; again, the vertical incision not only permits drainage at the lowest point of the skull, but it makes possible a large subtemporal bony opening without risk of loosening the attachment of the temporal muscle and fascia to the parietal crest, and thus a firm closure with no danger of cerebral hernia is assured.

7. The great frequency of temporosphenoidal lesions such as tumors, abscesses, and brain injuries make this routine exposure of the subtemporal decompression a most important aid in the treatment of underlying subarachnoid lesions.

CONCLUSIONS

The operation of cranical decompression is one that should be used much more frequently than it is at present; especially is this true in the conditions of brain tumor, brain abscess, brain injuries and in selected cases of spastic paralysis due to an intracranial hæmorrhage at birth.

The subtemporal method of cranial decompression is the ideal route; besides being less difficult technically, it exposes an area of the brain most frequently involved. This permanent decompression opening does not weaken the skull in that the thick overlying temporal muscle protects it most adequately so that hernial cerebri are not to be feared.

The operative mortality is low. Patients with intracranial conditions should not be permitted to become blind or to reach the dangerous stage of medullary compression without a subtemporal decompression being performed early.

DEPARTMENT OF TECHNIQUE

INTERPOSITION OPERATION FOR THE CURE OF PROLAPSUS UTERI AND CYSTOCELE

By FREDERICK W. JOHNSON, M.D., F.A.C.S., Boston
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AND
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Assistant Visiting Gynecologist, Carney Hospital

THE excuse for reporting our experience, in operating on 90 cases, and the end-results in 68 of them, is that practice has taught us a technique which not only facilitates the operative procedure, but secures excellent end-results and is attended with almost no danger and no shock. Our mortality has been nil.

Most cases of prolapsus with the usual attending cystocele, rectocele, and relaxation of the pelvic outlet occur in elderly and old women, a class of women who demand an operative procedure that is attended with as little danger and shock as possible. Almost all our patients were from the laboring class and as soon as possible were obliged to return to their homes and household duties, just the class that would put any operation for prolapsus and cystocele to its severest test.

The interposition operation described by Thomas J. Watkins, of Chicago, is the foundation on which we have built. The drawings, which were made from case No. 85, show in what way our procedure differs.

The following questions were sent to 90 patients, and 68 replied. The first was operated on May 31, 1909, and the last May 5, 1918, an average of about ten a year. Eighty-nine were operated on at the Carney Hospital.

1. Did the operations relieve you of the troubles of which you complained?
2. Is there falling down of the parts?
3. To what extent has your general health been improved by the operations?

One patient, sixty years of age, had no return of the procidentia for nearly one year, then a ventral fixation was done, there being no return of the cystocele. This also failed and she died two years later. Five had return of the procidentia soon after the operation, but no return of the cystocele. One had partial relief. One died during childbirth one year after the operation The doctor did not answer our letter asking for particulars. One has a twenty-two months old girl, was the "easiest of all her labors," no return of the "falling down of the parts." Four were relieved for various periods of time, now there is "falling down of the parts." One died of cerebral hæmorrhage two months after the operation.

From answers received from 68 patients it appears that 54 have been wholly relieved of the "troubles complained of" at the time of the operations; there has been no "falling down of the parts," and there has been "improvement in their general health.'

This is certainly gratifying as we know of no other operation for prolapsus uteri and cystocele, attended with almost no danger and no shock, that gives as good end-results. It is an operation from which elderly and old people recover quickly.

It was found necessary to repair or amputate the cervix in 55 of the cases, and Crossen's or Emmet's operation for relaxed pelvic outlet and rectocele was done in 76. The oldest patient was sixty-nine, the youngest twenty-one. In one case there was procidentia where pregnancy and childbirth had not been the cause. Forty-six were between fifty and sixty-nine years of age, while thirty were between forty and fifty.

The five cases in which there was return of the procidentia soon after the operation, and the cases in which there was only partial relief were among our first, and failure was due to not carrying out in detail the technique which experience showed us was necessary.

In every case in which there is a relaxed pelvic outlet a Crossen or, if there is much of a rectocele, a Bandler operation should be done.

Pregnancy should not occur after this operation.

In most operations for cystocele only the vaginal mucosa is removed and a return of the

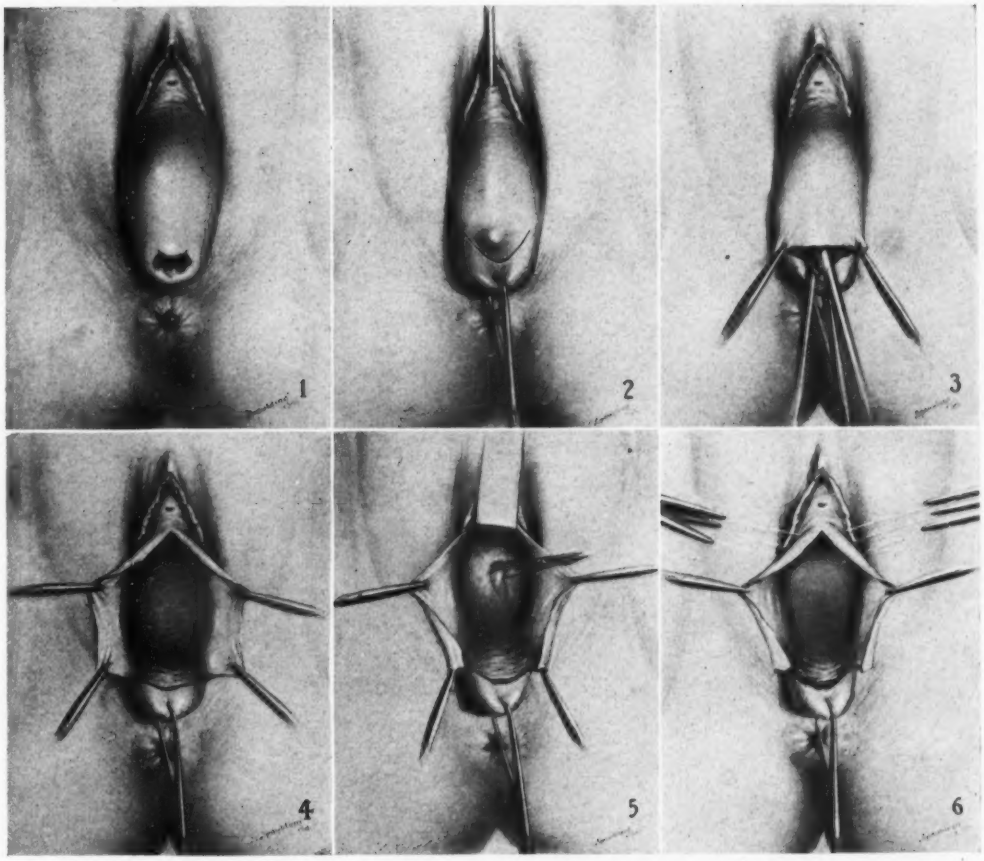


Fig. 1. Case No. 85.

Fig. 2. Same case. Male sound in the bladder, with point toward operator, to indicate where first incision is to be made.

Fig. 3. Upper edge of first incision, drawn down and held taut by two Ochsner clamps, while the bladder is being separated from the fascia of the anterior vaginal wall, by curved sharp-pointed scissors.

Fig. 4. Bladder freed entirely of fascia from fundus to vesical neck.

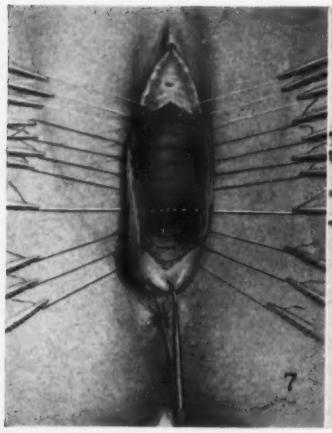
Fig. 5. Peritoneum has been opened and uterus is being delivered into vagina.

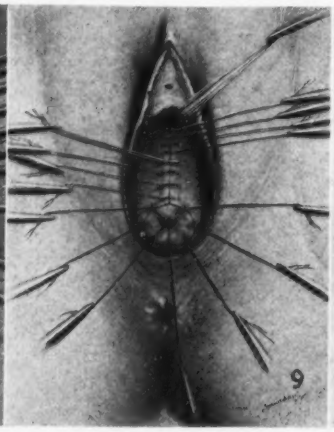
Fig. 6. First three sutures of silkworm-gut passed through vaginal mucosa, fascia, and deeply into anterior surface of the fundus uteri. These sutures remain *in situ* one month.

cystocele is almost certain to take place. It is only by separating the *fascia* completely from the bladder, removing what is necessary of it with the vaginal mucosa, to get rid of the cystocele, and then fastening the fascia and mucosa to the whole extent of the anterior surface of the uterus down to the cervix that one can secure a permanent anteversion of the uterus and an obliteration of the cystocele so that it will not return.

It is very difficult at the best to remove the fascia from the bladder in strips with scissors, and in some cases it is impossible. If the anterior vaginal wall, fascia and mucosa, is separated from the bladder first by curved pointed scissors (Fig. 3) and then by blunt gauze dissection no fascia will be left on the bladder. The fascia with its overlying vaginal mucosa will be an entity, and can be used to the greatest advantage.

It is necessary to cut through the fascia in the median line down to cervical tissue at the base of the bladder, sweeping it off from side to side until the whole base of the bladder is free. The





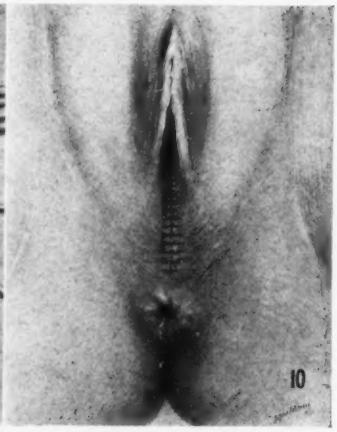


Fig. 7. Slack of anterior vaginal wall (cystocele) has been cut away. Vaginal mucosa and fascia are sutured to the anterior uterine wall from fundus to cervix with chromic catgut. A most important suture (marked red) is the one at the junction of corpus uteri and cervix. This straightens out the uterus, and throws the cervix back.

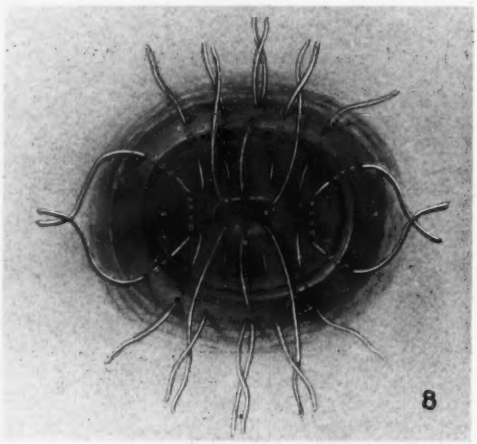
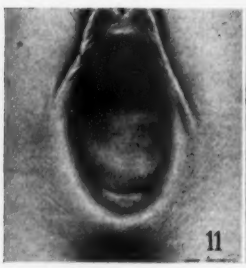
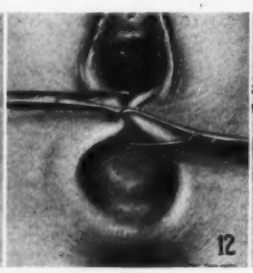


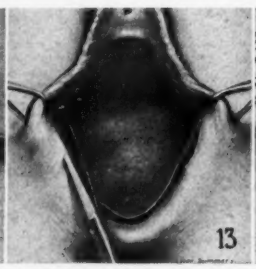
Fig. 8. Amputation of the cervix uteri. The two red sutures are most important ones.

Fig. 9. Cervix amputated and operation for interposition finished.

Fig. 10. Crossen's operation for relaxed pelvic outlet finished.







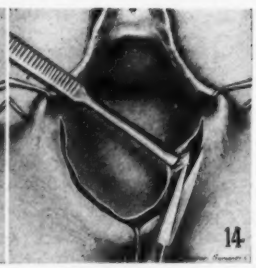


Fig. 11. The location of the incision for opening the pelvic floor. The author prefers to place the incision well within the vaginal opening, as indicated by the heavy black line. *xx* indicates the area to be caught by the forceps. This marks the end of the incision and is situated on each side just below the opening of vulvovaginal gland.

Fig. 12. Estimating the size of the repaired opening, by bringing together the extremities of the intended incision.

Fig. 13. Opening the pelvic floor with sharp-pointed scissors.

Fig. 14. Freeing the edges of the vaginal flap, preparatory to catching it with forceps.

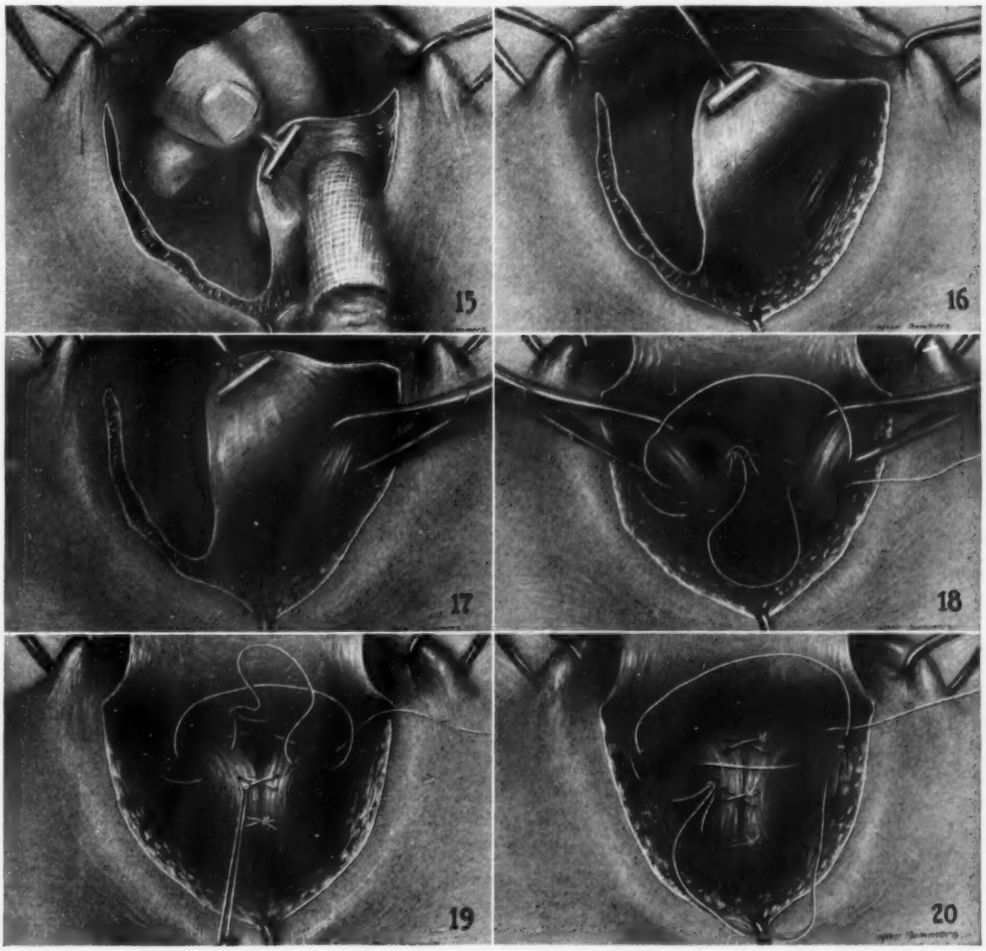


Fig. 15. Rolling off the underlying tissues from the vaginal wall with the gauze-covered finger. The motion is that of a push and a roll combined, and is made against the left forefinger which furnishes the counter pressure. The fingers are shown ungloved for better identification and appreciation of relations. They are of course gloved in the work.

Fig. 16. The flap has been turned back on the left side, showing the pelvic sling exposed in the depth of the wound.

Fig. 17. The sling caught with forceps and brought out for better identification and more accurate passing of the sutures.

Fig. 18. Sling brought into view on each side, and the first approximation suture passed. It is well to make two rounds with the suture before tying.

Fig. 19. First suture tied and left long as a tractor. Second suture passed and tied (below first), and third suture being introduced.

Fig. 20. All the sling-approximation sutures tied. The first suture passed through the more superficial tissues.

bladder is freed by gauze dissection from the fascia on the sides, and toward the urethra as far as necessary to take in the slack of the anterior wall, leaving enough to prevent too great traction when the sutures are tied.

When this is thoroughly done the bladder will slide off very easily from the anterior surface of the uterus before the index finger.

Freeing the bladder in this way allows it to be easily pushed up, and consequently it is not

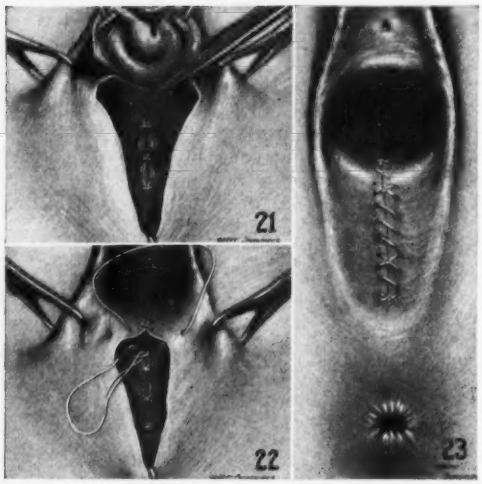


Fig. 21. Superficial perineal tissues approximated over the deep sutures. The excess of vaginal flap is being excised.

Fig. 22. Closing the vaginal wound.

Fig. 23. The vaginal wound closed. If a continuous suture is used it should be locked securely at intervals.

NOTE.— We use interrupted sutures throughout in the closure, see Fig. 10.

pressed upon by the fundus uteri when it is delivered into the vagina, and when it is fastened there.

It is very necessary to the patient's after-comfort that the bladder lie smoothly, not in folds, and the base be not elevated on the posterior surface of the fundus uteri. In many of the long standing cases there is a chronic cystitis at the base of the bladder which is caused by residual urine containing colon bacilli, and if possible this condition should be cured before an operation is attempted.

The bowels are not moved for seven days. The catheter is not used unless necessary, and after each voiding the parts are sprayed. After forty-eight hours, a short vaginal douche of sterile water is given through a soft catheter, morning and night.

For diet the white of an egg in one-third tumbler of flavored water is given every three hours when the patient is awake, for six days. As much water as the patient desires is given.

For the relaxation of the pelvic outlet we have used the operation described by H. T. Crossen, of St. Louis, in his *Operative Gynecology*, from which, with the author's permission, we have copied the drawings which we have used to illustrate this article.

UNUNITED FRACTURE OF THE PATELLA AND OF THE OLECRANON

BY FRED H. ALBEE, M.D., SC.D., F.A.C.S., NEW YORK
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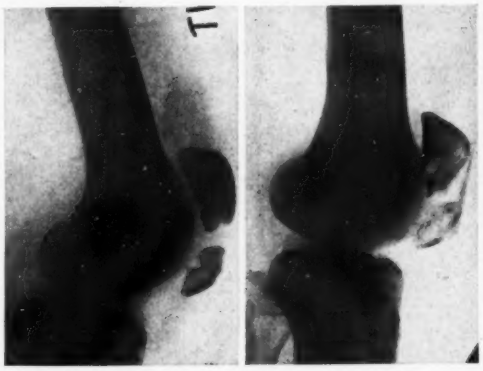
FRACTURES of the patella and the olecranon are analogous in so many of their clinical features that the writer has chosen to discuss them both in the same article. In both instances muscular action tends to produce wide separation of the fragments. The patella and the olecranon each overlies an important joint.

In treating a *fresh* fracture of either of these structures, the bone-graft is not recommended, its use being reserved for cases of long-continued non-union or mal-union. Furthermore the use of silver wire is condemned as a fixative agent because of its lack of strength and treacherous nature. The wire gives way particularly at the knot or twist. The latter defect was thoroughly established by the writer some years ago in a Government testing-machine for determining tensile strength. In many instances the wire cracked at the twist without the knowledge of the surgeon. A further objection to silver wire is that it is non-absorbable, acts as a foreign body and exercises a directly destructive influence on the bone with which it comes in contact. For these reasons kangaroo tendon is a far more preferable material for fixation purposes in all fractures.

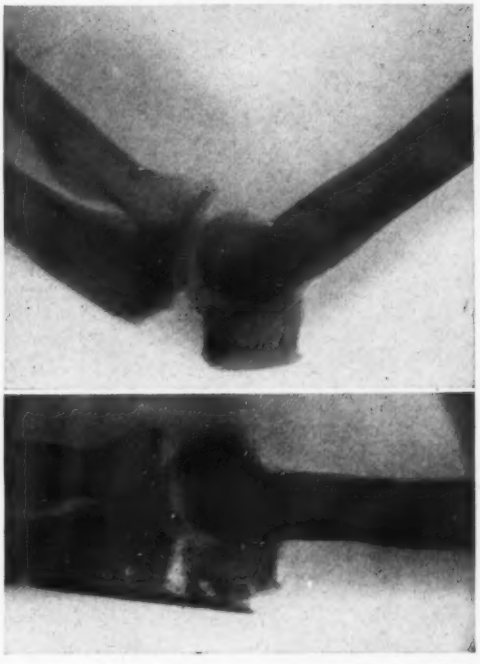
FRACTURE OF THE PATELLA

Fracture of the patella is of two kinds: (1) transverse, and (2) vertical, irregular, or comminuted. The subjects are usually adult males.

1. *Transverse fracture.* This type is usually the result of muscular action, and usually occurs



Figs. 1 and 2. Fracture of the patella before and after the insertion of an inlay bone graft. Figure 1 shows the separation of the fragments and the tilting forward of the proximal surfaces. In Figure 2 the approximation of the fragments and correction of their forward tilting are readily appreciable, while the outlines of the inlay graft and the progress of osteogenesis are well shown. The roentgenogram shown in Figure 2 was taken 8 weeks after implantation of the graft.



Figs. 3 and 4. Fracture of the olecranon before and after operation. Figure 3 illustrates the wide separation of fragments due to action of the triceps muscle, while Figure 4 shows the close approximation of the fragments secured by the inlay bone graft and the rapid osteogenesis which has taken place.

in an effort to prevent falling. With the knee bent at an angle of 60° to 90° and the ligamentum patellæ taut and drawn tightly against the femoral condyles, the pull of the quadriceps the largest muscle in the body, is suddenly exerted with full force at its insertion on the top of the patella, fracturing the latter and tearing the lateral expansions of the quadriceps tendon. The degree of separation of the fragments varies: There is always considerable, and there may be extreme, separation, the upper fragment sometimes being drawn up to the middle of the thigh.

The line of fracture is regular and almost exactly transverse. After the accident, tags of torn periosteum and fascia fall in between the fragments and become quickly adherent. The fragments are often rotated forward or backward on their transverse axes. Long-standing cases have an elongated fibrous band connecting the fragments.

Although the patient can walk, he does so with difficulty, swinging the leg forward and locking it in hyperextension before putting his weight upon it, but in some cases pain prevents the patient from walking and also from lifting the foot when lying down.

The diagnosis of transverse fracture is evident at a glance upon inspection of the roentgenogram. Clinical diagnostic features are: (a) inability to extend the leg, to raise the foot from the bed while recumbent, and voluntarily to straighten the flexed knee; (b) rounded swelling of the knee the result of effusion; (c) palpation of the fragments, the interval between them, and their mobility.

This fracture occasionally requires differentiation from rupture of the quadriceps and from rupture of the ligamentum patellæ or tearing out of its insertion, viz.:

1. *Quadriceps rupture.* The patella can be moved downward *in toto*, leaving a palpable gap *above* it, at the site of rupture.

2. *Rupture of the ligamentum patellæ or avulsion of its insertion.* The patella can be moved upward *in toto*, leaving a gap *below*, at which point the signs and symptoms are localized.

Treatment. Autogenous bone-graft for ununited transverse fracture of the patella. The usual treatment for fracture of the patella consists of exposing the line of fracture and uniting the fragments with either absorbable or non-absorbable sutures. Formerly, metal wire, such as silver

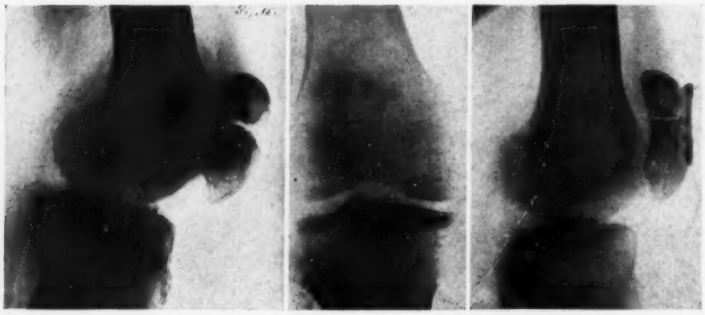


Fig. 5. Fig. 6. Fig. 7.

Figs. 5, 6, and 7. Fracture of the patella before and after correction by inlay bone graft. The three photographs are of the same case. In Figure 6 the outline of the graft is seen in relief in the anteroposterior view. In Figure 7 the graft is seen in profile while behind it and between the patellar fragments abundant osteogenesis is taking place.

or phosphorbronze wire was used; but recently the surgical pendulum has been swinging away from non-absorbable material and kangaroo tendon has been largely used. The metal wire formerly used was as a rule either placed in a drill hole in each fragment, or in such a way as to encircle the patella.

The degree of separation of the fragments in these fractures depends largely upon the amount of laceration of the capsule and connective tissue on either side of the patella. Muscle pull may interfere with the union of the patella fragments, however carefully the clots and fibrous material are cleaned from between them or whatever may be the material used to hold the fragments in close apposition. Not infrequently a re-fracture occurs, either immediately or remotely after operation, in spite of every precaution. Fibrous union, with a varying degree of separation of the fragments and a proportional amount of disability in the extremity, is a more frequent unfortunate result. To remedy either of these conditions, Rogers has suggested that an autogenous bone graft be taken from the crest of the patient's tibia and implanted on the front of the patella to bridge the line of fracture. It is believed that this is an important step and that it offers a trustworthy means of relieving this condition. It would seem, however, that Rogers' technique can be much improved by using the author's inlay method, which he has not only applied to relieve fibrous union and re-fracture, but which he offers as a means of securing immediate and solid bony union in certain fresh fractures of the patella (see Figures 1, 2, and 5 to 19). In other words, the inlay graft is a reliable preventive of fibrous union and re-fracture, as well as a remedy for those conditions when they already exist, and it obviates the employment of a foreign body. Besides affording slight and imperfect contact, a graft placed on the anterior surface of the patellar fragments is likely, on account of its superficial location, to produce pressure necrosis of the soft overlying tissues.

Technique. As in all bone-graft operations on the extremities, a tourniquet is applied to the upper portion of the thigh. The fracture fragments are approached by a U-shaped flap the apex of whose convexity lies over the ligamentum patellæ, its base over the femoral condyles or by the incision shown in Figure 8. All fibrous tissue between the fragments is carefully removed; in the case of re-fracture or fibrous union, the fragment ends are freshened (Fig. 9). The fragments are approximated, and the lateral rents in the fibrous capsule are repaired at the sides with interrupted sutures of medium kangaroo tendon (Fig. 10). The central portion of the anterior surface of the patella is then denuded of its periosteum and peri-osseous tissues by turning back laterally flaps of these structures on each fragment (Fig. 11).

An outline of the bone to be removed, about one and one-fourth by three-fourths of an inch, is made on the anterior surface of the patella with the point of a scalpel. With the small motor-saw, cuts are made to a depth of one-third of an inch along the outlines already made (Fig. 13). The fracture surfaces of the patellar fragments are tilted forward and with the small motor saw and a

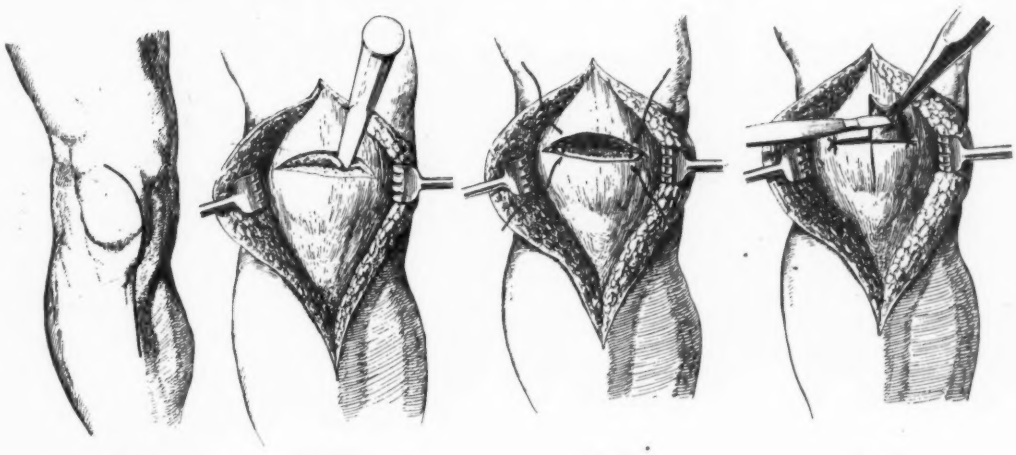


Fig. 8. Fig. 9. Fig. 10. Fig. 11.

Fig. 8. Semilunar and vertical skin incision used by the writer in exposing the patella for the repair of an ununited fracture.

Fig. 9. Removing the fibrous tissue from between the patellar fragments by means of a sharp thin osteotome.

Fig. 10. Lateral rents in the fibrous capsule are partially sutured at the sides with interrupted sutures of small kangaroo tendon.

Fig. 11. Central portion of anterior surface of patella is being denuded of its periosteum and periosseous tissue by turning back to each side flap on each fragment.

narrow thin sharp osteotome the bone within the previously made saw-cuts is removed to a depth of one-third of an inch from the anterior patellar surface (Fig. 14).

With the patellar fragments in good apposition careful measurements are made of the inlay gutter with calipers. The antero-internal surface of the upper portion of the tibia, where the surface is broad and the cortex thin, is exposed and, by means of the caliper measurements or a wax model of the gutter in the patella the outline of the inlay graft required is made in the periosteum (Figs. 16,and 17.) The cortex in this portion of the tibia is of the proper thickness for the graft. The inlay is inserted with its periosteal surface anterior, and the periosteal flaps of the patella are pulled over it with interrupted chromic catgut sutures. The rents in the capsule are then sutured with kangaroo tendon as far as the sides of the patella (Fig. 19.) To insure greater fixation, the fragments are securely held by a figure-of-eight suture of medium-size kangaroo tendon passed laterally to the anterior portion of the ligamentum patellæ and quadriceps tendon, directly above and below the fractured bone, crossing in front of the transplant. The skin incision is closed by a continuous suture of No. 1 plain catgut. The limb is immobilized in a plaster-of-Paris splint for four weeks.

This operation is of the greatest advantage where there has been a fibrous union in an old case and a separation of the fragments coincident with a shortening of the quadriceps tendon and muscle; and when the fragments cannot be brought into close apposition this space can be spanned by a long graft, which, as the result of hypertrophy, will entirely, or to a large degree, fill in the hiatus between the fragments. It is advisable to stimulate osteogenesis by placing fragmented grafts about the inlay.

2. *Vertical, irregular, or comminuted fracture of the patella.* This type is due to direct trauma, usually a fall. There is little, if any, separation of the fragments. The lines of fracture are irregular, and may be ragged. There is no interposition of soft tissue between the fragments, The fracture is frequently compound.

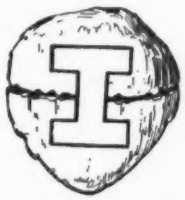


Fig. 12. A type of the inlay graft used by the writer for the repair of fractures of the patella.

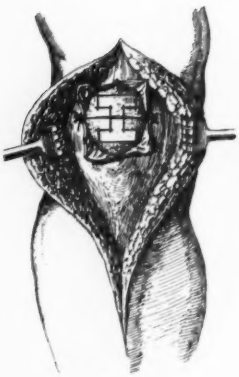


Fig. 13.

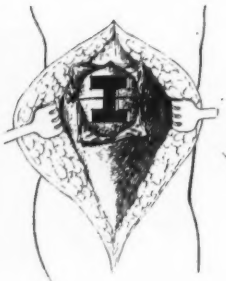


Fig. 14.

Fig. 15.

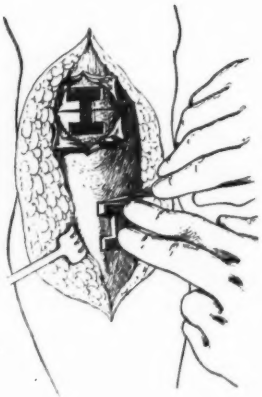


Fig. 16.

Fig. 13. An outline of the bone to be removed, about 1¼ by ¾ inches, has been made on the anterior surface of the patella with the scalpel. With the writer's small motor saw cuts have been made to a depth of one-third of an inch along the outlines thus made.

Fig. 14. The fracture surfaces of the fragments have been tilted forward and with small motor saw and narrow thin sharp osteotome the bone within the previously made saw cuts has been removed to a depth of one-third of an inch from the anterior patellar surface.

Fig. 15. Melted paraffin has been poured into the "mold" in the patella. After hardening the model is pried out of its bed with a narrow thin osteotome.

Fig. 16. The wax model of the gutter in the patella is laid upon the antero-internal surface of the upper portion of the tibia and the graft outlined in the periosteum.

The diagnosis of this type depends chiefly on roentgenography, in the absence of which pain, loss of function, localized tenderness, mobility of the fragments, and the very small interval between them (in contradistinction to wide separation in transverse fracture) are sufficient.

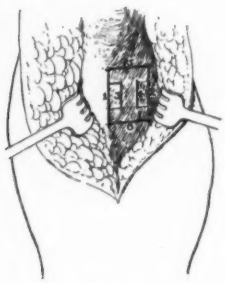


Fig. 17.

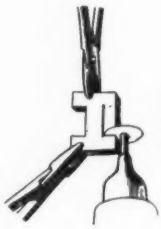


Fig. 18.

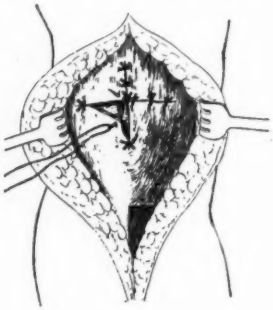


Fig. 19.

Fig. 17. The material for the inlay is removed from the tibia *en bloc*, by cutting with the small motor saw along the outlines previously made with the wax model. The cuts should be made in the manner shown in this figure and in sequence as indicated by the small numbers, *1*, *2*, *3*, *4*, *5* and *6*. The block of bone is then lifted from its bed with a narrow thin osteotome.

Fig. 18. After its removal the graft material is held with two pairs of hæmostats, while the two longitudinal cuts are connected by cross cutting with the small motor saw and the two intervening portions of the bone are removed.

Fig. 19. The inlay has been inserted with its periosteal surface anterior and the periosteal flaps of the patella are pulled over it with interrupted chromic catgut sutures. The capsule rents are here shown sutured with kangaroo tendon. The fragments are still more securely held together by a figure-of-eight suture of medium kangaroo tendon which is passed laterally through the anterior portion of the ligamentum patellæ and quadriceps tendon, directly above and below the fractured bone, crossing in front of the transplant. The skin incision is closed by a continuous suture of No. 1 plain catgut and the limb immobilized in a plaster-of-Paris splint for 6 weeks.

Treatment. These cases, due to direct trauma with little or no separation of the fragments, do well under immobilization in a plaster-of-Paris splint from toes to groin and continued for a period of five to six weeks. Or a posterior wire splint can be used with the leg strapped to it and elevated on pillows to relax the quadriceps, and with coaptation splints applied to the front of the thigh, to insure its relaxation. At the end of five to six weeks, the patient can get about on crutches with a light posterior splint on the leg, and massage combined with very light passive motion may then be instituted. Weight-bearing should be cautiously used, at first without flexion.

FRACTURE OF THE OLECRANON

This not uncommon fracture is due either to direct trauma (the usual cause) or to overactivity of the triceps. In most cases the fracture is clean cut and transverse, and there may be considerable separation of the fragments. In children the fracture may result from a fall on the elbow.

The symptoms consist of loss of active extension of the forearm, of varying degrees of severity. With the forearm extended, mobility and crepitus may be obtained by grasping and moving the olecranon. Roentgenography offers the most certain means of diagnosis.

Treatment. In fresh fractures of the olecranon, exposure by incision, drilling the fragments, and the insertion of kangaroo tendon for their fixation is believed to be the best method of treatment. In ununited fractures of this process, the inlay graft, held in place by kangaroo tendon, can be easily applied on account of the superficial location of the olecranon, and promises better results than are offered by any other procedure (Figs. 3, 4, 20, and 21.) The graft is inlaid to the tip of the olecranon, on the one hand, and as far into the shaft on the other as the amount of bone sclerosis indicates. A sliding graft, or one obtained from the tibia may be used, as conditions indicate; or a peg graft may be used instead of the inlay, as the surgeon may elect. For this particular fracture, the peg should be made with a generous head; this can be easily done by not pushing the graft completely into the dowel-cutter. The forearm is flexed, and the insertion of the triceps into the olecranon split in equal halves down to the bone; the center of this end surface of the olecranon is then selected and a drill hole (using the proper size drill) is bored completely through the olecranon fragment and into the long (shaft) fragment of the ulna for a distance of approximately 1¼ inches. The drill is then withdrawn, and the peg (about ¼ inch in diameter) driven home. The dowell peg in this instance is obtained from the tibia and sharpened by means of the author's motor lathe.

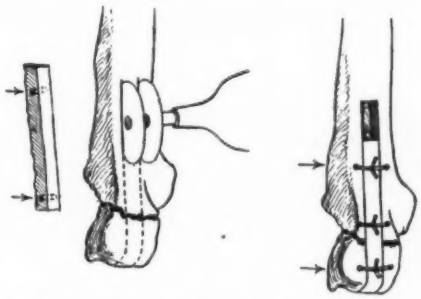


Fig. 20. Technique of sliding inlay graft for fracture of the olecranon process. Arrows indicate drill holes in graft.

Fig. 21. The inlay graft is held firmly in place with kangaroo tendon.

SOME TECHNICAL POINTS IN GASTRO-ENTEROSTOMY AND GASTROPLICATION[1]

By A. SCHWYZER, M.D., F.A.C.S., St. Paul, Minnesota

THE technique of gastro-enterostomy has been established for such a long time and has been so copiously discussed and illustrated, that I hesitate to present a few minor points, which may have been part of the technique of many others. Nevertheless they seem of sufficient interest to be discussed in brief. They apply to the side-to-side methods. The Y-shaped gastro-enterostomy is not considered in this paper.

The bugbear of gastro-enterostomy has been for a long time the vicious circle; and it has never quite disappeared. No doubt, atony of the stomach walls is an important factor in its formation. The surgeon therefore has to do everything possible to secure an easy outlet from the stomach and to avoid the creation of any difficulty of passage. The manner of attaching the gut, whether this be in the iso- or the anti-peristaltic sense, has produced much discussion. The easy floating away of the efferent loop has always been the one factor considered, though this is perhaps of less importance than what happens to the afferent loop. Nevertheless it must be admitted that, in case the efferent loop should become fixed, even in a moderate way, by postoperative adhesions, a kink may be disastrous. While a free intestinal loop, even if kinked, may easily move on its contents, the difficulty at the site of the gastro-enterostomy lies in the circumstance that the peristaltic wave of the gut, when it passes the gastro-enterostomy opening, loses much or most of its chymus, in case the stomach is greatly relaxed. The *vis a tergo* thus is lacking. Under these conditions it is possible that even comparatively slight obstacles become serious. Antiperistaltic attachment of the jejunum may give better results to many operators, because by this procedure the inlet is kinked off, a beneficial feature in itself.

If the pylorus is patent, food will pass through it even after gastro-enterostomy, and will appear at the afferent loop. The afferent opening will, therefore, not have the same tendency to contract and remain contracted as the distal jejunum, which in case of atony of the stomach is not forcibly offered food. Now as soon as there is no free outlet from the lower opening, the duodenum and the jejunum above the gastro-enterostomy will become distended. In vicious circle the afferent loop becomes so ballooned that the efferent opening is compressed and pushed out of the way. To guard against all this we should bear in mind the picture of this fully established vicious circle. We, therefore, have to see that the afferent opening cannot become too large, because by enlarging it annexes that originally neutral territory, the portion of gut which lies between the two ends of the gastro-enterostomy incision. It annexes it for the formation of a wide funnel, and the lower jejunal opening is then pushed to the wall and more or less shut by a spur. Besides the guarding against a too wide upper opening we must remember that the upper loop can become very large and bulging. Even if the upper opening is reduced in size, the distended loop above it, though very short, could become so large that it might compress the outlet. For this reason we do well to fix the afferent gut for some distance on the stomach. For the efferent gut it is desirable that it lead rather freely away from the stomach, and that its opening be somewhat funnel-shaped. To accomplish this in posterior gastro-enterostomy we have for years used the following simple means (Figs. 1 and 2):

First. The stomach is drawn through the slit in the mesocolon as far as is feasible.

Second. The edge of the mesocolon is fastened to the stomach as far on the periphery as possible. In front the mesocolon is often really fastened to the anterior wall of the stomach by grasping the stomach wall through the omental attachment, where it can be had between vessels.

Third. The gastro-enterostomy is made large enough to allow the tips of the four fingers in it.

Fourth. The loop is attached in the isoperistaltic sense; and the stoma extends from a point about halfway between the greater and lesser curvatures on the afferent (left) side to close to the greater curvature on the efferent end. Thus, after the stomach is replaced, the gastro-enterostomy opening has a downward course on the posterior wall of the stomach, and is as much a postero-inferior outlet as can well be procured.

Fifth. After the posterior Lembert suture is placed, the gut incised down to the submucosa, the second suture applied and the mucosa opened, we then make it a point to grab with the third suture a broad edge of mucosa. It never appealed to me to excise the mucosa. What protects the tissues against secondary ulcer on the suture line

[1] Read before the Western Surgical Association, Chicago, December, 1918.

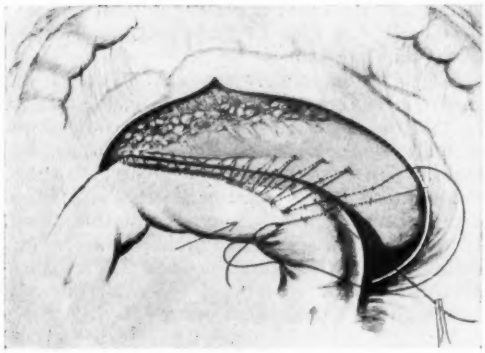


Fig. 1.

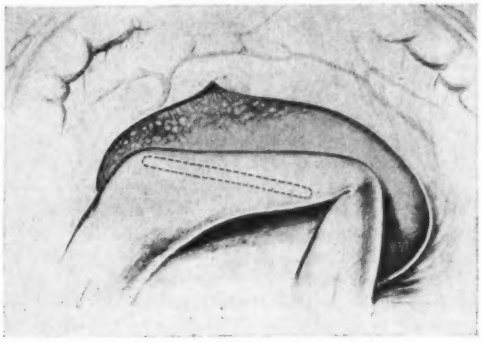


Fig. 2.

is the mucosa, and for this reason we prefer to secure a bulky covering by pulling ample mucosa over the wound. For the same reason that we are principally concerned to secure a tight covering with mucosa, we do not lay great stress on carefully inverting the mucosa when the anterior half of this suture is placed. If the edges are somewhat everted, the suture does not look as neat; but seen from inside there is no exposed submucosa. The middle suture buries this eversion, and the sewing goes more quickly.

Sixth. The anterior Lembert suture is placed in such a manner that, after the distal half is finished in the ordinary way, it not only pulls the jejunum on the proximal half over to the left and upward by a slanting direction of the suture (see Fig. 1), but the suture in its progress toward the left angle gradually includes broader peritoneal surfaces and thus pulls the gut over onto the stomach. This creates a narrowing and a kinking of the afferent gut, and at the same time brings about a broader agglutination at the point where the most pulling is to be expected. The lower jejunal opening is drawn into a more favorable position and its lumen is held open and free from obstructing folds, while the upper opening is rendered rather inaccessible from the gastro-enterostomy side. This point I have demonstrated many times and it appears to be of value. The sketch shows the suture in a somewhat exaggerated way to emphasize its peculiarity. In reality it is usually preferable not to grasp quite as much surface, and to increase the effect to the desired degree by a few additional interrupted sutures. The kinking and therefore comparative inaccessibility for food of the afferent loop is probably, as mentioned before, a beneficient feature in the antiperistaltic attachment method; and this principle is underlying in Polya's attachment of the gut after resection of the stomach. We make use of this same principle whenever an anterior gastro-enterostomy has to be performed, and the necessity of making an entero-anastomosis in this procedure is thus avoided.

In ulcers of the lesser curvature excision is advised by leading authorities. Rutherford Morison, however, among others had good results with gastro-enterostomy alone. End-result inquiry in our very small material yielded the following results: Of ulcers of the lesser curvature distinctly away from the pyloric area there were in our material ten cases. In two a resection of the stomach, including the pylorus, was performed; both report themselves as well (after 3½ and 2 years). Another case, after good operative recovery, could not be traced. One case, operated upon 1½ years ago, is greatly improved. The remaining six cases were entirely relieved by the operation.

In these cases the aim was to make the opening in the stomach away from the pyloric grinding mill, but still at the bottom of the stomach. Furthermore, we were anxious not only to make the outlet extra large, but to pull enough stomach through the mesocolon to have it pouch. If a rapid and free emptying is particularly desired, an elliptical excision of the edge of the gastric muscularis, not necessarily including the mucosa, may be of assistance.

GASTROPLICATION

Atony of the stomach with a sagging downward and a dilatation of this viscus is a condition which is found in patients who usually have suffered for a long time from stomach symptoms due principally to retention and from a reduced nutrition.

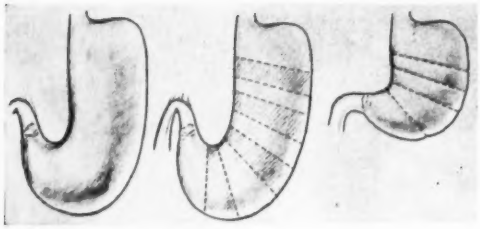


Fig. 3.

Time does not permit dwelling upon the different methods of treatment in these cases with their mostly unsatisfactory results. Suffice it to add that, though the surgeon withholds operating as long as he can, he may be driven by the severity of the symptoms and the prolonged misery of these patients to try operative relief. Bircher as the first one offered a reefing of the stomach which produces horizontal folds, through which the greater curvature is raised and its distance from the lesser reduced. Now on examination, these stomachs, for the most part, show that even the lesser curvature has greatly sagged down and the whole organ is like a long bag hung up only on the two ends, i.e., the cardiac and the pyloric area. On the pyloric side the attachment is not to the pylorus proper so much as to the first portion of the duodenum, where the fixation occurs by the gastroduodenal artery, the bile ducts and the extraperitoneal attachment to the pancreas. A kink in the uppermost portion of the duodenum is the consequence. The kink in its turn causes a more or less marked retention with a gradual dilatation as a further result.

Gastroplication as advised by Bircher creates longitudinal folds in the stomach. The whole organ assumes the shape of a long sausage. The sagging of the lesser curvature is not changed and the acute angle at the outlet is not improved. However, if the folds are made in a transverse direction, the stomach is very much shortened by them. The degree of shortening can indeed be chosen by the operator. He can make as many transverse folds as seems necessary. Through this the stomach is lifted toward the cardia, and the lesser curvature is shortened and stretched. The kink at the duodenum is effectively counteracted.

In general one is very reluctant to credit any operation of this type with much merit, and let me add that I myself am not enthusiastic about such methods. Nevertheless one is at times confronted with a case in which the ptosis is so severe that some corrective measure, perhaps in addition to a drainage operation, appears desirable. Even admitting that the stomach probably undoes our folding after a while, and conceding that improvement after these operations, when done in conjunction with a drainage operation, is principally to be attributed to the latter, our experience leads us to believe that there is some merit in the procedure. The posterior wall was left untouched in our cases. It could of course be reached to some extent through an opening in the gastrocolic ligament; but it seemed too much surgery in view of the moderate promise of such a surgical interference.

In the course of a study of the end-results of our stomach operations during the last fifteen years, we have found thirteen cases of severe dilatation and ptosis. In one we simply made a gastro-enterostomy and had a good result. In the remaining 12 cases we performed the transverse reefing of the stomach. However, on account of a distinct retention we added a gastro-enterostomy in six instances and a pyloroplasty twice. In four cases nothing but the reefing was done. The questionnaire yielded the following end-results:

Two only slightly, if any, improved after 2 and 4⅓ years.
Two improved after 3⅓ and 6½ years.
Four greatly improved after 5¾, 6½, 6¾ and 7⅓ years.
One practically well after 5½ years.
Three very well after 5½, 9⅓ and 14 years.
One not found (after good operative recovery).
The four cases with nothing but a gastroplication are:
One slightly improved after 4⅓ years.
One greatly improved after 6¾ years.
One very well after 9⅓ years.
One not found.

I simply give these data for what they are worth. The indications for such a procedure are surely very limited and rather rare, but as long as plication is still done now and then in cases of an extreme condition, it seemed permissible to bring this modification to your attention, because it corrects, or helps to correct, the kink at the outlet of the stomach.

A SUMMARY OF THE SURGICAL TREATMENT OF GOITER[1]

By MILES F. PORTER, M.D., F.A.C.S., Ft. Wayne, Indiana

GENERALLY speaking, surgical services are sought by goiter patients, because of (1) toxic symptoms, (2) pressure symptoms, (3) deformity, and (4) a combination of these difficulties.

When patients with symptomless goiters seek the services of the surgeon for fear their benign goiters may become troublesome, and not until then, will there be achieved all that is possible in the relief and cure of this disease.

I should like to repeat here what I have said in effect several times before,[2] namely, that the wisdom of removing simple goiters for fear of their becoming toxic is quite as evident as is the wisdom of removing warts, moles, scars, etc., for fear of their becoming malignant. Subtotal thyroidectomy is the operation of choice in all patients who are good surgical risks. "Safety first" is the slogan here as universally elsewhere and therefore the incision should be ample and located with a view to an adequate exposure of the gland. Whether or not the muscles should be divided on one or both sides depends upon the individual case. The rule should be to divide the muscles when necessary to secure adequate exposure of the operative field. When divided, the section should be made as near the upper attachment as possible. It is preferable to grasp all the tissues, including the superficial fascia and muscles on the side or sides to be divided with two forceps and make the incision between. Properly placed sutures will coapt all structures divided and effectually prevent hæmorrhage.

For circumscribed hypertrophy, cysts or adenomata, the incision may with safety be made relatively small, provided it be properly located. There is no orthodox incision for goiter.

In cases of general hypertrophy wherein subtotal removal is contemplated, a full exposure of the gland should be secured not only for the sake of safety, but for the further purpose of enabling one to judge more accurately of the characters presented by the different parts of the gland. In a previous paper[3] I called attention to the fact that the hyperactive portions of the gland could usually be distinguished from the normal or inactive portions. It is generally believed, I think, that the hyperactive gland structure is usually red, rather firm, and somewhat resembles beef steak. On the contrary, it has been my observation in quite a number of cases, that the hyperactive, trouble-producing portion of the gland, as indicated by the microscopic picture present, is often, if not usually lighter in color and softer than the normal gland structure. Further observations made since those upon which the statements made in the paper above referred to were based, confirm the conclusions reached therein.

With the style of dress commonly worn by women today, it is quite impossible to locate the incision so that the scar will be covered. It follows, therefore, that the scar should be as inconspicuous as possible. To achieve this end, the incision should be made to follow the natural folds of the skin, the skin should be cut through at right angles to the surface, and the skin wound should be closed with subcuticular sutures with the aid of adhesive plaster, if necessary, to perfect the coaptation. A stitch scar in a place where it attracts attention is a surgical sin. No other method of wound closure with which I am acquainted gives as good medical results as the one here recommended.

Lobectomy is frequently an unsatisfactory operation in that it leaves the neck asymmetrical and often fails to give adequate relief.

The portions of the gland structures to be left after thyroidectomy should be selected, in so far as is possible, with a view of avoiding future asymmetry. One should leave not any more gland structure than would amount to one-fifth the normal — the aim should be to leave normal gland tissue. Non-functionating gland tissue is useless, and hyperplastic tissue, if left, will keep up the symptoms of intoxication for a longer or shorter time, and sooner or later degenerate and become useless. That it will not always be possible to select normal tissue to leave, I am of course well aware, but I am convinced that efforts made along this line are well worth while.

It is perhaps better always to divide the isthmus completely when it can be done without additional risk. This procedure is advised with a view to the relief or prevention of the pressure symptoms. Preservation of the posterior capsule will effectually protect the parathyroids and recurrent laryngeal nerves. Drainage adds both to the safety and comfort of the patient and it is, therefore, seldom wise to omit it. Strips of rubber dam make the

[2] Detroit M. J., 1915, March.

[3] Ann. of Surg., Phila., 1916, October.

[1] Read before the Southern Surgical Association, Baltimore, December, 1918.

best drainage material. Drains should be removed as soon as the discharge becomes negligible, usually at the end of 48 or 72 hours after the operation.

Adhesion of the skin to the larynx or trachea is not an infrequent cause of annoyance. This can be avoided by securing the interposition of a layer of cellular tissue between these structures.

Generally speaking, ether anæsthesia is the safest and most satisfactory. To this rule there are of course exceptions, but they are rare. It is generally conceded that when a patient dies from appendicitis it is almost always because someone has blundered. The sooner it is generally conceded that it is a grievous error for a goiter patient to put off consulting the surgeon until the time for safe surgery is past, the sooner will the number of goiter deaths be decreased. In the present state of our knowledge concerning goiter there is no excuse for any but a very small proportion of goiter patients first seeking surgical relief after the time for safe surgery is past.

For the preparation of the sub-standard risks for the major operation, injections of boiling water into the gland substance is more effectual than any other known procedure. In a large percentage of patients with small goiter of the diffuse hyperplastic variety, injections of boiling water should be the treatment of choice in that it is efficacious and entails less risk and less loss of time than any other method of treatment equally efficient. This method of treating goiter has already been published.[1] It is now in quite general use and a detailed presentation of the subject is unnecessary.

In closing I should like to urge the especial importance of foci of infection in goiter patients. Not infrequently the removal of these foci will cause the goiter symptoms to disappear. To allow such foci to remain after thyroidectomy is to invite a recrudescence of the goiter symptoms. Besides it should be remembered that thyroidectomized patients are especially vulnerable.

[1] Surg., Gynec. & Obst., 1915, xx, 15.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

QUARTERLY MEDICAL CLINICS. A series of consecutive clinical demonstrations and lectures. By Frank Smithies, M.D., at St. Augustana Hospital, Chicago. St. Louis: Medicine and Surgery Publishing Company, Inc., vol. i, No. 1, 1919.

INFECCIONES DE TIPO GRIPAL. By Antonio Piga and Luis Lamas. Madrid. vol. 1, 1919.

SURGERY OF THE THORAX AND VISCERA; Symptoms, Diagnosis, Indications and Treatment. By Benjamin Merrill Ricketts, Ph.B., M.D., LL.D., F.A.C.S. Cincinnati, 1918.

NOTES ON PATHOLOGICAL AND OPERATIVE OBSTETRICS. By Lyle G. McNeile, M.D. Los Angeles: Division of Obstetrics, College of Physicians and Surgeons, Medical Department of the University of Southern California, 1919.